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A TEXT-BOOK
of the
PRACTICE *of* MEDICINE

By

JAMES M. ANDERS, M. D., PH. D., LL. D.

Professor of Medicine, Medico-Chirurgical College Graduate School, University of Pennsylvania; Consulting Physician to the Jewish Hospital and to the Widener Home for Crippled Children; Officier de l'Instruction Publique, etc.

FOURTEENTH EDITION—WITH THE ASSISTANCE OF

JOHN H. MUSSER, JR., B. S., M. D.

Associate in Medicine, University of Pennsylvania; Physician to the Philadelphia General Hospital; Physician in Charge of the Medical Dispensary, University of Pennsylvania; Assistant Physician and Chief of Dispensary, Presbyterian Hospital

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PREFACE TO THE FOURTEENTH EDITION

I HAVE endeavored to bring the present or fourteenth edition of this work up to date, paying especial attention in the revision to the practical phases of internal medicine. While text-books must teach the theory of medicine, it has been my further aim to aid the student and practitioner to gain a knowledge of methods of a practical kind for the observation and detailed study of disease. In general, those complaints which come most frequently under notice have received chief attention. Certain sections, however, *e. g.*, that on Typhoid Fever, which is no longer the protean disease it once was, have been abridged. On the other hand, the description of numerous diseases, not a few of which were prevalent during the World War, has been amplified on account of the importance of newly developed facts. Among the latter are Typhus Fever, Yellow Fever, Cerebrospinal Meningitis, Pneumonia, Ictero-hemorrhagic Spirochetosis, Diabetes Mellitus, Scurvy, Pellagra, Pernicious Anemia, Exophthalmic Goiter, Focal Infection, Tuberculosis, Mumps, Measles, Hemolytic Jaundice, Hemolytic Anemia of Pregnancy and the Puerperium, and Banti's Disease, as well as Asthma and Hay-fever by incorporating the further studies of these disorders in their relations to foreign protein.

In the section on Diseases of the Heart certain diagnostic criteria for determining the presence or absence of true valvular disease have been presented. The various types of Heart Block, as determined by the electrocardiograph, are discussed from the clinical standpoint. Among sections which have been entirely rewritten is that of Influenza, and the studies and experiences of the recent pandemic have been incorporated. Again, the relation of Varicella to Herpes and the vaccination treatment of the former have been noted.

Among complaints not hitherto described in this work are the following: Bronchial Spirochetosis, Streptococcic (Hemolytic) Pneumonia, Trench Nephritis, Disordered Action of the Heart, Chronic (Syphilitic) Aortitis, Interstitial Emphysema, Epidemic Encephalitis, Oxycephaly, Wood (Methyl) Alcohol Poisoning, and Botulism.

In this, as in previous issues of the work, diagnosis, including differential diagnosis, and treatment have been especially stressed. The fact that a knowledge of the special causes of individual diseases is of material assistance in their recognition and treatment has been given attentive consideration.

I can only hope that this edition will maintain the position as a text-book of medicine which the previous issues held.

My acknowledgments and best thanks are due to Dr. John H. Musser, Jr., the assistant editor, for invaluable aid in the task of revision and for seeing the work through the press, and to Dr. H. Leon Jameson for much help. I am also under many obligations to Dr. Charles S. Potts who has thoroughly revised the section on Diseases of the Nervous System.

JAMES M. ANDERS.

1605 WALNUT STREET,
PHILADELPHIA, PA.

PREFACE

THIS work is meant to introduce the student to the present state of our knowledge of the practice of medicine in general and of the diagnosis, differential diagnosis, and treatment of disease in particular. The historic development of the subjects treated has been either briefly given or intendedly omitted, since this scarcely falls within the scope of a practical treatise on medicine. Although the book as a whole is submitted to the critical judgment of a learned profession, it may be pardonable to emphasize, provisionally, a few features pertaining to the mode of treating the separate subjects, or the arrangement of the material under the latter—to indicate some of the more salient lineaments, so to speak, in the general design. Since in medical schools it is taught from a separate chair, the pathology (special) of the individual affections has almost invariably been taken up before the etiology; from this point the student will find the story of each affection a continuous one. The practitioner, however, must ever aim to associate the clinical symptoms with the morbid lesions.

Under special etiology the bacteriology has been prominently mentioned, since we owe to it the rapid progress that is being made in the study of the causation of disease.

The differential diagnosis has in many instances been tabulated—an ear-mark that I confidently believe will be found especially helpful. It may be stated that not less than fifty-six diagnostic tables are scattered throughout the work, and that by far the greater number of these are my own.

Such formulæ have been introduced into the text, and only such, as a more or less extended experience has shown to be possessed of real therapeutic importance. Whilst these, and all additional points relating to the treatment of the single affections, may serve as guides, particularly to the beginner, I fully appreciate how often the practising physician is

placed in a position in which he is compelled to form a therapeutic judgment for himself. Whenever the dosage is stated, the metric equivalent is placed in parentheses, the number of grams being stated in round numbers (3j—4.0; 3j—32.0) in order to render it of greater practical value. In all instances, however, in which this would involve an important difference in quantity the exact decimal figures are given. A considerable variation from the usual classification of diseases may be observed, but this is accounted for in the text wherever it occurs.

Preference has been given to the modern orthography and terminology, not only because it is more euphonious, but also because of its adoption by the standard lexicographers.

I have gleaned without stint from medical literature with a view to bringing the book up to date, and if I have failed to give full credit in every instance, my grateful acknowledgments are here due and are cheerfully made. The chief results of my personal experience and observation, extending over a period of two decades, and derived from both hospital and private practice, will also be found upon these pages.

I wish to thank Prof. W. C. Hollopeter, who has written some of the articles upon the diseases of children, as measles, chicken-pox, mumps, whooping-cough, and the acute diarrheas, and who has kindly aided in the preparation of those upon diphtheria and scarlatina.

My cordial thanks are due also to Dr. C. L. Furbush for kind aid in preparing some of the illustrations, to Doctors Robert N. Willson, Howard S. Anders, and Geo. W. Pfromm for valuable assistance while the work was passing through the press, and to Dr. A. M. Davis for preparing the index.

JAMES M. ANDERS.

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PART I

INFECTIOUS DISEASES

TYPHOID FEVER

(*Enteric Fever; Abdominal Typhus; Ileotyphoid; Nerven Fieber*)

Definition.—An acute infectious disease of which the definitive cause is the specific bacillus of Eberth (*Bacillus typhosus*). It is characterized, pathologically, by hyperplasia and sloughing of Peyer's patches and the solitary follicles of the intestines coupled with parenchymatous changes in the principal viscera, and clinically by its gradual onset, peculiar temperature-curve, swelling of the spleen, rose-colored spots, diarrhea, tympanites, sero-reaction, and a liability to certain complications (intestinal hemorrhage, perforation, etc.). The disease, however, is a bacteremia, and typhoid infection is no longer an anatomic entity, and does not always produce typical typhoid fever.

History.—Although known beyond the reach of tradition, typhoid fever was clearly distinguished from typhus at a comparatively recent date. Louis of Paris in 1829 proposed the term *typhoide*, but it remained for Gerhard of Philadelphia to discriminate typhoid from typhus fever as the result of his own precise clinical observations. His account of the disease was ably corroborated by the writings of E. Hale and James Jackson, Sr. (1838, 1839). Later Shattuck of Boston and Jenner of London made important contributions to the subject. Shattuck's experiments on typhus and typhoid fevers at the London Fever Hospital in England, and Alfred Stillé's studies of the former affection in Dublin and Naples, and of the latter in Paris, increased greatly our knowledge of these diseases. As a result of the labors of the above-mentioned American authors the true nature and identity of typhoid fever were appreciated in America at an earlier day than in either France or England.

Briefly, the decade from 1840 to 1850 witnessed the overthrow of erroneous notions concerning the similarity of typhoid and typhus fevers, on the one hand, and the establishment of their points of dissimilarity on the other.

Pathology.—The lesions produced by typhoid fever may conveniently be divided into two groups: (1) Primary lesions, due to the direct effect of the special bacillus upon the lymph-follicles of the intestines, the mesenteric and other lymph-glands, the gall-bladder, and the spleen. Typhoid septicemia without localizing lesions is also a recognized form of the disease. (2) Secondary lesions, due chiefly to the indirect effect of the typhoid bacillus and secondary infection, for the occurrence of which the essential lesions furnish the golden opportunity.

(1) The PRIMARY MORBID CHANGES in the Peyer patches and solitary glands of the intestines are divided, usually, into four stages:

(a) **The Stage of Infiltration.**—The lymph-follicles become engorged (hyperplasia), particularly Peyer's glands in the ileum and near the valve,

The stages thus far described do not, strictly speaking, follow one another, since two or more may be illustrated at once by a group of ulcers occupying the intestines. When death occurs during a relapse fresh ulcers are observed by the side of those partially healed.

The Mesenteric Glands.—Changes in the mesenteric glands occur simultaneously with those in the intestines, and those situated opposite to the lower third of the ileum, the portion of the bowel showing the most extensive ulceration, are most profoundly involved. Hyperemia and, later, swelling due to cell-infiltration are among the earliest changes, and correspond with the lesions noted in the intestines (*vide supra*). The mesenteric glands exhibit great variations in size, ranging, as they do, from that of a pea to a hen's egg. Their color is a grayish red. Resolution commonly occurs, but, if it does not, then necrosis of the central portion (due, most probably, to the same causes that produce necrosis of the intestinal lymph-follicles) occurs.

The Spleen.—With rare exceptions the spleen becomes enlarged in typhoid fever. At first hyperemic, the tissue then grows soft and granular, and at times is almost diffuent on section. Infarction is not a rare occurrence and may lead to suppuration. In rare instances, either spontaneously or as the result of injury, the spleen may rupture, and the records of 2000 postmortems at the Munich Pathologic Institute furnish 5 cases. Perisplenitis rarely occurs.

Gall-bladder.—This may show catarrhal inflammation, and rarely a croupous, diphtheritic, or ulcerative inflammation leading to perforation. Westcott has tabulated 30 cases of typhoid infection of the gall-bladder that resulted in perforation. Chiari's and Flexner's figures show that typhoid bacilli are found in the gall-bladder in more than 50 per cent. of the fatal cases. Chiarolanza found that typhoid bacilli injected intravenously reached the gall-bladder in 18 out of 23 cases, entering through the capillaries of the mucosa and submucosa. (*Vide Acute Infectious Cholecystitis.*)

Mallory has shown that the typhoid bacillus produces a toxin which causes proliferation of the endothelial cells along the line of absorption from the intestines, both in the lymphatics and blood-vessels. These cells increase in size and number, and manifest phagocytic properties.

(2) LESIONS DUE IN PART AT LEAST TO SECONDARY INFECTIONS.—The lesions in other organs are of subsidiary importance, and, while they are to some extent secondary in nature, we cannot draw a sharp line of distinction between these and those that are primary. In the kidneys, pleura, pharynx, larynx, and tonsils primary implantation of the typhoid bacillus may rarely occur (*vide infra*).

The *liver* early becomes hyperemic, and later is softer and paler than is natural. Rarely infarction and abscess occur. Mesenteric abscess and perforative appendicitis may be followed by pylephlebitis.

The *kidneys*, like the liver, exhibit parenchymatous degeneration. They are somewhat pale looking, are cloudy on section, and slightly swollen, and under the microscope granular and fatty degeneration of the epithelial cells of the convoluted tubules is observed. More rarely the lesions are those of *acute hemorrhagic nephritis*. The mucous membrane of the pelvis of the kidney is not infrequently the seat of a mild grade of catarrh and, rarely, of diphtheritic inflammation. Typhoid cystitis is still more common, and the bladder may also be the seat of diphtheritic inflammation. Rarely orchitis is encountered. On making cultures from sections of the kidneys not a few observers have been able to demonstrate the presence of the specific bacillus of typhoid.

In the *lungs* are found morbid lesions in nearly all cases of typhoid fever, and belonging to the essential pathologic processes is bronchitis, due to a congested and catarrhal state of the bronchial mucous membrane. The lesions

The blood shows few important alterations. The red blood-corpuscles are relatively increased during the febrile period and markedly diminished during convalescence, but the great loss of water during the former period and a reabsorption during the latter will explain these interesting facts (Henry). Leukocytosis is absent (*vide infra*, p. 36).

Etiology.—Bacteriology.—The bacterium which is the specific cause of typhoid fever was discovered by Eberth, whose researches were later confirmed by the investigations of Gaffky and others.

General Characters.—It is a short, thick bacillus, about three times as long as it is broad, with rounded ends (Fig. 1). It is motile, due to the presence of cilia, and when stained exhibits vacuolations that have been mistaken for spores. It is easily stained with all the anilin dyes.

Experimental Typhoid.—Inoculated into lower animals the bacillus frequently causes fatal results from a typhoid septicemia without producing the lesions characteristic of typhoid in human beings, although occasional typical typhoid ulcers have been observed. It has been found that the ulcerative intestinal lesions produced by the inoculation of the bacilli or their toxins in large quantities into the blood of rabbits may also be caused by other bacteria, including the *B. coli communis*. Metchnikoff,¹ however, has administered foods contaminated with weak dilutions of bacillus-infected feces to chimpanzees; they contracted characteristic typhoid fever. Parker and Franke² found that bacilli when injected into rabbits which were killed ten minutes later were chiefly lodged in the liver.

Fig. 1.—Typhoid bacilli with flagella; $\times 1000$.

Usually, in making a *bacteriologic diagnosis* the typhoid bacillus is to be differentiated from those organisms that morphologically resemble it and present almost identical characteristics upon various culture-media, such as the bacilli of dysentery, including the Shiga and Flexner types, *B. paratyphosus*, "A" and "B," and the *B. coli communis*.

Nature of the Typhoid Toxin.—The toxic agent in typhoid fever is probably a poison derived from the bacilli, either through the disintegration of the bacteria with the formation of poisonous protein products or as a result of some definite constituent of the cell which is liberated by autolysis after the death of the organism (endotoxin). Probably both factors are, in part, responsible for the symptoms of the infection together with a third possibility which is not definitely proved, *i. e.*, a toxin secreted by the living organism, an exogenous toxin, a notable example of which is the toxin secreted by the diphtheria bacillus.

Distribution in the Body.—The bacillus has been found in the intestinal tract, the lymph-glands, the contents of the intestine, the spleen, the liver, the gall-bladder, the rose-colored spots, the blood, and the bile. The *Bacillus typhosus* is most abundant in the duodenum and jejunum; it is practically constant in cultures made from the mucosa of the stomach (Jürgens). The *Bacillus typhosus* is demonstrable in the stools (in about 50 per cent. of the cases), the urine (Wright and Semple), the sputa, the vomitus, milk, and the sweat. Less commonly it has been found in foci of suppuration and in exudations (pleural, endocardial).

¹ *Jour. Amer. Med. Assoc.*, April 16, 1910.

² *Jour. Med. Research*, 1919, xxxix, 301.

occurred at or beyond the seventieth year. Young children are not exempt, and cases among them are of rather frequent occurrence, if we except those under one year of age. When contracted late in pregnancy typhoid may be congenital (Freund and Levy). The typhoid bacilli have been successfully cultivated from the fetus, and Mossé and Fraenkel have confirmed the observation that the Widal test can be obtained from the placenta and blood of the fetus.

(e) **Sex** probably does not affect the degree of liability in typhoid.

(f) **Individual Predisposition.**—This is usually *acquired*. An instance of *acquired* predisposition is to be noted in the great susceptibility which exists among persons who have recently moved from rural districts to cities. Thus, Louis found "that of 129 cases, 73 had not resided in Paris over ten months, and 102 not over twenty months." There is evidence to show that the disease is on the increase in rural sections. Fulton claims that propagation is, in general, from the country to the city.

Immunity.—The occurrence of typhoid fever confers an approximate, though not an absolute, immunity against subsequent attacks. Most persons, however, enjoy natural immunity from the affection.

In this connection two questions present themselves for consideration:

(1) **WHAT ARE THE METHODS OF CONVEYANCE OF THE POISON TO HEALTHY PERSONS?**

Isolated cases and epidemics of typhoid fever are alike to be attributed to antecedent cases of the disease, and this fact presupposes that the bacillus of typhoid leaves the body of the sufferer. It does so in the stools, the urine, and occasionally in the vomitus and sputum.

The dejecta and the urine, which are the principal sources of infection, may be conveyed to well persons by—

(a) **Infected Drinking-water.**—In most instances the poison is transmitted from those affected with the disease to those in health through the drinking-water supply, as shown by many epidemic outbreaks in which the mode of origin has been traced. Wells, storage reservoirs, springs, and rivers may become contaminated and cause an epidemic.

In the spring of 1885 a most deplorable epidemic occurred in Plymouth, Penna., a town of 8000 inhabitants. This epidemic was investigated by Shakespeare and L. H. Taylor, and was found to have arisen from a single case of typhoid occurring in a house on a hill which sloped toward the water-supply of the town. This patient was ill during January, February, and March, while the ground was frozen and covered with snow, upon which the dejecta were thrown. On March 25th there was a considerable rainfall, followed by a sudden thaw, and the water ran at once through the various surface channels into a brook, which, in turn, emptied into the reservoir. On April 10th other cases of the disease appeared, and those citizens who obtained their water from other sources than the infected reservoir escaped. The outbreaks at Maidstone (1897), at Butler, Pa. (1903), and Coatesville, Pa. (1914), are convincing and instructive as regards the causative influence of a contaminated water-supply.

(b) **Infected food** frequently conveys the poison. Milk may become polluted by water which has been used either to wash the cans or for diluting purposes, or the bacilli may be transferred to milk by the unclean hands of the milker. Numerous instructive epidemics, originating in infected milk, have been reported. E. B. Bigelow has reported a milk-borne epidemic which was traced to one male bacilli carrier, and involving 204 cases. The occurrence of numerous cases among children suggests contaminated milk. Epidemics of typhoid have been clearly caused by ice-cream and candies.

(b) The possibility that the bacilli may reach the blood-stream through the *respiratory organs* must be conceded; and hence the added possibility that they may set up initiatory lesions either in the tonsils, lungs, or pleura, passing thence into the circulation, must also be granted. Vaughan inclines to the opinion that the bacillus may be inhaled in the infected dust by troops on the march. Complete desiccation, however, soon destroys the typhoid germ. Primary localization of great severity may also occur in the kidneys and cerebrospinal meninges, giving rise to special clinical varieties (*vide infra*).

(c) **Typhoid Septicemia.**—By this is meant a general infection with the bacilli without localized lesions. The special mode of infection is not clear. Brion and Kayser conclude from extensive bacteriologic and clinical studies that typhoid fever may start as a lymph-and-blood affection (possibly entering by way of the tonsils).

(d) Typhoid infection predisposes the system to secondary infections with various bacilli (streptococcus, staphylococcus, *B. coli communis*, pneumococcus). The portals of entrance for these micro-organisms are various (*e. g.*, respiratory tract, lymphatics).

Clinical History.—I. INCUBATION.—The average duration of the period of incubation, or the time between the introduction of the poison into the system and the appearance of the first active symptoms, ranges from ten days to three weeks; this interval may rarely be shorter, although oftener it is somewhat longer. During this period the patient may experience no deviation from health, but in most cases there are prodromal symptoms, such as languor, loss of appetite, nausea, headache, neuromuscular pains in the back and limbs, a disinclination to exercise, etc. These symptoms last from a few days to a week or more.

II. GENERAL SYMPTOMATOLOGY AND COURSE.—On account of the peculiar temperature-curve in typhoid fever its course falls naturally into three periods—the stage of development; the acme or fastigium (corresponding to the height of the disease); and the stage of decline or defervescence. It is convenient to speak of the various weeks of the affection when referring to these stages. Thus, the first week represents the stage of development (*stadium incrementi*), the second and third weeks (in cases of average severity) the fastigium, while the fourth week in the typical form (the third week in mild cases) corresponds to the third stage (*stadium decrementi*) of the disease.

(a) **Stage of Development.**—The invasion, as a rule, is gradual, the symptoms being chilliness and feverishness, with increase in the severity of the prodromal symptoms. At or about this time nose-bleed may betray the nature of the disease. Bronchitis is an extremely frequent early symptom. Typhoid fever rarely starts in with a distinct *rigor*. The symptoms just described are quickly followed by a prostration sufficiently well marked to compel most patients to take to their beds. From this latter event is usually dated the *onset* of the affection. It is safer, however, to regard the time of occurrence of the above-mentioned symptoms as the time of onset.

The *onset* may be marked by symptoms resembling influenza (Bunce). In my experience cases in which general pains, including backache or slight pharyngitis, are seen at the onset are not rare. Among soldiers in the recent European War Goldscheider points out that the first symptoms were often those of sciatica or other neuralgia, cholecystitis, cystitis, tonsillitis, or deafness. Again, invasion may be ushered in by various nervous symptoms (*e. g.*, convulsions in children) or marked pulmonary features, especially those of severe bronchitis, or by gastro-intestinal disturbance, *e. g.*, vomiting and diarrhea.

With the progress of the initial period the symptoms usually increase in severity; the *fever* rises day by day, terrace-like, till, at the end of four or five

the same is true of the morning remissions. A glance at the temperature-charts (Figs. 2 and 3) will show that the morning remissions touch a level from one-half to one degree lower than the preceding evening registers. This stage is rarely met.

When the fastigium is reached, the evening temperature may be 103°, 104°, or 105° F. (39.4°-40.5° C.), and is usually thus maintained, with the

Fig. 2.—Curve in severe typhoid.

slight morning remissions. The tide-like character of fever-curve seen in the initial period is absent. Often during the latter half of the fastigium (the third or fourth week of the disease) the morning fall of temperature becomes decidedly greater. According to my own observation, the height of the fastigium is reached a day or two after its onset or at the end of the first week of the affection. Marked morning remissions are a favorable indication. On the

fever produces a decided lowering of the temperature. (5) Collapse of the circulation sometimes occurs with a notable remission of temperature—an ominous association of events, and one which I observed in two cases occurring in females in the Medico-Chirurgical Hospital. In one of these cases two such periods of collapse occurred, and in the other, three, though both finally recovered under prompt and continuous stimulation. Occasionally *hyperpyrexia* is observed in typhoid fever, and most frequently just before dissolution, when the thermometer may register 108° or even 109° F. (42.2° – 42.7° C.). A fresh rise with marked irregularity of temperature may occur during the latter part of the fastigium or the period of decline, and is often dependent upon some local complication (late pneumonia, parotitis, etc.).

The stage of defervescence is sometimes much prolonged, though most frequently there is simply a slight evening elevation (99° to 100° F.— 37.2° – 37.7° C.), the morning temperature being normal. The causes of retarded decline are, for the most part, obscure. I believe that many of them are ascribable to a mild grade of intestinal intoxication, and in my hands a mild saline laxative has been the means of cutting them short in a number of instances. An examination should, however, be made for some localized inflammatory complication, though this is not always discernible, as in the case of suppuration in the mesenteric glands. Sluggish typhoid ulcers which refuse to heal promptly may act as a cause of the slow decline; they are often due to the post-typhoid anemia and exhaustion.

Post-typhoid Elevation of Temperature.—After both the evening and morning temperatures have become normal, fresh temporary elevations (102° or 103° F.— 38.8° – 39.4° C.) frequently appear. They are, as a rule, unassociated with any other symptoms, and at the end of a few days the temperature falls rapidly to the normal. These are termed *recrudescences*, and are to be distinguished from true typhoid relapses. They are probably produced in various ways—by errors in diet, constipation, mental emotion, excitement. “There are cases in which the presence of the fever seems to be really a nervous phenomenon” (Osler). It is most common in children and in persons of a decidedly nervous temperament. Certain local sequelae may cause post-typhoid fever, such as abscess and periostitis. Rarely during convalescence a sudden and marked elevation of temperature, accompanied or not by rigor, occurs, but it is usually of short duration and seldom is of serious import. I saw, with the attending physician, Dr. Modell, a case in which the temperature had been normal for six days, when rigors, followed by steep elevations of temperature, occurred several times and at intervals of thirty-six or forty-eight hours. These high temperatures were followed by a rapid decline to the normal and by sweating, leaving the patient profoundly exhausted. Subsequently the convalescence was slow, but uninterrupted.

(b) *Skin.*—The *eruption* is highly characteristic, and usually decides the diagnosis. It makes its appearance on or about the eighth day, and sometimes a little later. Occasionally it does not appear until the tenth or twelfth day of the disease. It consists of distinct, rose-colored, and slightly elevated papules, having a rounded or lenticular form and a diameter varying from one or two to three lines. The papules are almost invariably found upon the trunk, and especially upon the upper part of the abdomen and the lower part of the thorax, to which regions they may be wholly confined. They may, however, be absent from the usual seats and present elsewhere, so that the sides of the trunk, the back, and the thighs should always be inspected. They disappear upon pressure, but reappear when the pressure is removed. These rose-colored spots last three or four days, and appear in successive crops, each one being made up, usually, of a few spots—a half-dozen to a dozen. Rarely the erup-

nation, remnants of food and grayish-yellow fragments (necrotic crusts of Peyer's plaques) from $\frac{1}{2}$ to 1 inch in length may be detected. Laboratory tests demonstrate the presence of the typhoid bacillus in the dejecta. *Tympanites*, mainly affecting the colon, is a common though rarely a striking feature, and cases of a quite serious nature are observed in which the abdomen presents a concavity throughout the entire illness. The latter is less unfavorable by far as a symptom than excessive tympanites, which interferes with both the respiration and heart action. Tympanites is apt to be most marked in serious cases which have diarrhea as a prominent symptom, though the latter may not even be present. It is due to the generation of gas from decomposing food, and to the arrest of peristaltic movements in consequence of degeneration of the muscularis of the intestines. *Pain* is absent in the majority of cases, and when present is not intense, save in rare instances. Pressure upon the ileocecal region usually causes a *gurgling noise*, but, although this symptom is commonly present, it is not characteristic of the disease. There is generally also a slight degree of tenderness of the abdomen under pressure, most marked in the right iliac fossa, and hence, in all probability, due to the presence of ulcers in this region. Absence of tenderness, however, is not a safe indication of the absence of extensive ulceration. *Extreme sensitiveness* generally denotes peritonitis (often without perforation), although the symptom may be marked in constipation.

Intestinal hemorrhage occurs in from 4 to 7 per cent. of cases, its frequency varying with different epidemics. The hemorrhages appear almost invariably during the latter part of the second and third weeks, being caused by the opening of blood-vessels during the necrotic or ulcerative process. The amount may be small, or it may be from 1 to 2 or 3 pints (0.5–1.5 liters), or even more. In one of my own cases the total amount of blood discharged from the bowel was nearly 5 pints (2.5 liters), and yet the patient recovered. The blood presents a dark hue, and that which is passed last may be tarry. Roman has examined the feces in 50 cases of typhoid fever with a view to the detection of occult bleeding. Blood was found in 14 cases, and of these, 7 were severe, 3 moderately severe, and 4 slight.

The significance of intestinal hemorrhage is always grave. On the other hand, recovery is possible even if the hemorrhage be copious and oft-repeated; and in general terms it may be said that death supervenes in from 30 to 40 per cent. of all cases. It occurred in more than the usual proportion of cases under my care during the Spanish-American War, probably owing to the fact that the men were conveyed from the various distant camps to the hospital. A fatal result may occur as the direct effect of a profuse hemorrhage. When death does not follow immediately, the signs of collapse and of anemia appear; yet intestinal hemorrhage may rarely exert a favorable influence, stupor and delirium quickly giving place to consciousness.

Perforation, which almost invariably produces fatal diffuse peritonitis, is the accident most to be dreaded. It does not bear a fixed relation to the severity of the affection. According to Fitz, who tabulated 4680 cases of typhoid fever, there is a mortality of 6.58 per cent. from perforation of the bowel. Scott's statistics, embracing 9713 cases from English, Canadian, and American hospitals, give a mortality of 3.6 per cent. from perforation. It is much more common in males than in females, and appears in a ratio of about 71 to 29. Age has a decided influence, the complication occurring oftenest between ten and forty years of age, while in children it is rare. It may occur at any time in the course of typhoid fever, but it is most common between the second and fourth weeks of the disease. In the cases analyzed by Fitz perforation was found in the ileum in 81.4 per cent., in the large intestine in 12.9 per cent., in

Carlson, who has studied so carefully and thoroughly the physiology of the stomach, advances the suggestion that during fevers toxins are formed which have a direct depressive action on the gastric cells so that they do not react to secretory nerve impulses and secretagogues. During convalescence the appetite returns, becoming even voracious. *Nausea* and *vomiting* may occur during any stage of the disease, but are most common at the beginning. When they appear as late symptoms they are probably excited either by a typhoid ulcer or by peritonitis. Nausea is often traceable to other causes—*e. g.*, to errors in diet or to the use of irritating medicaments, but vomiting also occurs from unknown and inevitable causes. It may become a grave symptom. Hiccup is a rare but serious symptom. Hematemesis has been observed, although practically unknown.

The *pharynx* frequently shows *catarrhal irritation*, and the patient may complain of dryness or a burning sensation in the throat. Actual *sore throat* may be present at the time of onset, associated with a diffuse *erythematous rash*, suggesting scarlatina.

There may appear upon the tonsils peculiar patchy elevations, whitish in color, which undergo subsequent ulceration. It is not improbable that these lesions result from the local action of the specific bacillus in an unusual situation. *Thrush*, affecting the mouth, throat, and even extending to the esophagus, not infrequently arises as a complication. The *tongue* is heavily coated, as a rule, with a yellowish-white fur; later it clears off near the edges and top, while the center becomes dry or brown and sometimes fissured. The lips are also dry, sometimes fissured, and often covered with dry, black crusts (*sordes*). *Ulcerative stomatitis* may occur if the mouth is not kept clean. Under these circumstances secondary lesions evincing unpleasant and even serious symptoms may also arise in organs more or less remote from the mouth, and among these is *parotitis*, which is most probably caused by the staphylococcus or streptococcus reaching the parotid gland by the way of Steno's duct. The condition is betrayed by such symptoms as pain, redness, and finally by fluctuation, with an elevation of the bodily temperature. It is a late-appearing development, and is usually unilateral, though it may be bilateral. *Suppurative otitis media*, a rarer complication, arises in a similar manner, the pathogenic agents reaching the ear through the eustachian tube.

(d) **Respiratory System.**—As pointed out in the section on Pathology, *bronchitis* is almost invariably present. The condition is recognized by the existence of numerous sibilant râles. Bronchitis is often a striking feature in the early stage of typhoid fever, and then, except this fact be remembered, room for error of diagnosis exists. Moreover, in cases that are improperly treated the bronchial secretions are apt to accumulate, and a well-marked bronchitis may be the result. It may be said, however, that, as a rule, bronchitis does not assume a severe type in cases which receive proper attention from the beginning, provided the patient is not unusually stupid or unconscious. When the nervous phenomena are pronounced, and the patient maintains the dorsal decubitus, bronchitis of a severe grade and affecting the smaller bronchi is almost inevitable. The occurrence of an intense bronchitis is also favored by conditions such as corpulence, advanced age, and emphysema. These cases are apt to lead to lobular infiltration—*aspiration-pneumonia*.

Lobular pneumonia may take on a putrid nature and the consolidated area may become *gangrenous*. As a sequel, *pleurisy* with effusion or *empyema* may originate in consequence of the infiltrated lobules being contiguous to the pleura. If the lobules occupying the periphery of the lung become gangrenous, perforation of the pleura, leading to *pyopneumothorax*, may result. As pointed out by

circumstances a soft systolic murmur may be faintly heard along the left border of the sternum. Among occasional *complications* presented by the heart is pericarditis, and still less frequent is endocarditis. Myocarditis is more common. The sudden development of circulatory collapse in this disease, as previously noted, may be due chiefly to myocardial insufficiency; and there may be a brief though alarming derangement of the heart action, due to functional disturbances.

The *pulse* is accelerated, but not, as a general rule, in proportion to the height of the temperature until late in the affection. Its average rate is from 84 to 108. The temperature, moreover, may be of average height, while the pulse is normal or only slightly quickened throughout; and hence the increase in the pulse-rate cannot be due solely to the elevation of temperature. The bradycardia in typhoid is most probably attributable to a state of vagotonia. As before intimated, the extreme debility which comes on during the third week in severe cases may have, as one of its manifestations, a very rapid pulse, reaching to 160 or more (the so-called running pulse), and with or without marked irregularity. Slight *irregularity* is sometimes observed either during the height or decline of the affection, but, as a rule, proves of no serious consequence. Marked temporary accelerations are often caused by undue exertion or mental excitement. The lowered arterial tension is shown by a dicrotism of the pulse—a non-characteristic symptom, however, since it is well marked in other acute infectious diseases, although less commonly. During convalescence the pulse often becomes abnormally slow (*brachycardia*). *Per contra*, less commonly the pulse-rate is increased during convalescence. I have found the systolic arterial pressure during the fastigium to range from 110 to 125 mm. Hg; it declines further late in the disease. The fall in the diastolic pressure is proportional. During convalescence the blood-pressure again rises, reaching the normal in from two to four weeks.

Venous thrombosis occurs in 1 per cent. of all cases (Murchison). Its most frequent seat is the left femoral, and the next most frequent the right femoral vein, and it is generally the result of cardiac weakness, except perhaps in those rare instances that arise early in typhoid. In most cases there is, doubtless, more or less phlebitis, and the bacilli have been found in the thrombus. The condition may be bilateral. Coming on, as it usually does, during convalescence, it manifests itself by swelling and edema of the extremity affected. There is *pain* in the thighs and calves, and tenderness over the course of the vein, and often over the calf of the leg as well. It causes *fever* of a moderate grade and irregular type. In the course of from two to three weeks the swollen member may be reduced to its normal dimensions. This complication is usually not serious, but occasionally clotting extends into the pelvic veins and into the vena cava, thence even into the right auricle, inducing fatal syncope, and sudden death has resulted from the detachment of emboli. The thrombus may undergo suppuration, leading to systemic septic infection.

Thrombosis and *embolism* in the arteries, with renal, splenic, and pulmonary infarcts, may be encountered in typhoid fever.

The large or small arteries may become obliterated either by embolism or thrombosis in extremely rare instances, but whether the thrombosis under these circumstances is brought about by a peculiar condition of the blood which favors clotting, or by a localized arteritis, is not definitely known. If, as is usual, the femoral artery be involved, the blood-supply to the foot and leg is cut off and *gangrene* of those parts must follow. The condition may be bilateral. It may be detected early, owing to the absence of a femoral pulse, before the signs of gangrene appear. The condition is highly dangerous.

first few days of the illness. In a small class of cases, however, the effects of the typhoid bacilli or their toxins are manifested solely in the nervous system from the very onset. In such there are violent headaches, retraction of the head, rigidity, photophobia, and muscular twitchings (rarely convulsions)—all of which symptoms indicate *meningitis*. The diagnosis of meningitis as a complication must be made with extreme caution and only when lumbar puncture gives positive information, since, no matter how complete the clinical picture may be, the postmortem examination usually reveals a total absence of meningeal inflammation. It must be recollected, however, that the lesions may be wholly microscopic. *Vertigo* may accompany the headache, but it seldom outlasts the latter. Before delirium manifests itself wakefulness and restlessness at night are very annoying, and later the same symptoms may be observed associated with the delirium. In cases of moderate severity *mental dulness*, and even *actual hebetude*, are almost invariably present. Questions are apt to be answered inconsistently and in monosyllables.

Delirium is frequent in the severer cases. It is, however, not an uncommon event for those of moderate severity to be free from this symptom throughout the attack. It is, as a rule, most marked at night or at some time when the patient is left alone. His delusions may impel him to attempt to leave his bed, but more commonly there is *mild* or *noisy delirium*, with more or less restlessness. He may lie somnolent, soliloquizing in a loud whisper (muttering delirium), and this so-called *typhomania* may gradually give place to actual coma toward the close of the middle period of the disease. In not a few cases—mild or severe—*coma* is developed suddenly, and is often a mortal symptom. Still another unfavorable sign is a picking at the bedclothes or a grasping at imaginary objects (carphologia).

The delirium may assume an hysteric type, the patient usually exhibiting the saddest emotions, and if he be an alcoholic he may be seized with *delirium tremens*. In a case of typhoid fever that I saw with Dr. S. W. Morton hysteric delirium developed during early convalescence, but did not last more than twenty-four or thirty-six hours.

The *motor nerves* also present notable disturbances in association with the sopor and the forms of delirium previously described. Slight twitchings of the muscles of the face and extremities are quite common, and when they affect the tendons of the wrist and fingers the term *subsultus tendinum* is applied. The lips, tongue (especially when protruded), lower jaw, and even the extremities are often in a state of constant tremor. During this motor irritability the reflexes are increased, but when profound coma comes on they are either largely diminished or totally abolished. The toxins of the typhoid bacillus, acting poisonously upon the nervous centers, are undoubtedly the cause of the nervous symptoms in typhoid.

Nervous complications and *sequelæ* may arise. Chief among these is *paralysis*, which is most probably due to neuritis. The lesion may involve one, two, or more nerves, causing paralysis of one limb or, more rarely, a true paraplegia. *Aphasia* may be a sequel, particularly in children. *Hemiplegia*, due to hemorrhage or a localized encephlitis, may occur either as a complication or sequence of the disease. Following typhoid fever the patient may exhibit evidences of *mental enfeeblement*, and even *insanity* where a predisposition to this condition has existed; and insanity is relatively more common after this disease than after any others belonging to the same class. I have seen four instances which recovered, while Osler has seen five, four of which ended similarly. It is in most cases, as pointed out by Wood, a confusional insanity, due to exhaustion and impairment of the nutrition of the nerve-centers, while in a smaller contingent it takes the form of a true melancholia. The *typhoid state*

is often associated (*vide* p. 26). After the conclusion of typhoid, as well as during its course, *neuralgia* affecting the occipital and other cranial nerves may occur. Great hyperesthesia of the skin and muscles is common during convalescence, attacking the lower extremities by preference (Strümpell) and associated with, at times, the so-called "tender toes," a true neuritis. The so-called "typhoid spine" (Gibney) has also been observed, and consists of an acute inflammation of one or more vertebræ following typhoid. The chief symptoms are pain in the back and hips of a lancinating character. The point of origin appears to be the small of the back; thence the pains extend paroxysmally up and along the spine and to the abdomen. They subside gradually, leaving the back weak and painful on attempts at turning in bed, etc. Plantar and other skin-reflexes are increased, and the knee-jerks are preserved. G. E. deSchweinitz has described the *ocular complications* and *sequelæ* of typhoid fever. Affections of the conjunctiva and cornea and retinal hemorrhage are perhaps the most frequent, although optic neuritis and affections of the uveal tract also occur. *Deafness* of different types may rarely develop either during the acme of the disease or convalescence.

(g) **The Urinary System.**—*Urine.*—This is lessened in quantity and high colored, with an increased specific gravity up to the arrival of the stage of decline. About this time, and rarely earlier, it grows light in color, larger in quantity than the normal, and the specific gravity is relatively diminished. Both urea and uric acid are increased during the earlier stages, and sometimes throughout the attack, while during convalescence both are diminished. On the other hand, the chlorids are diminished during the active stages of the disease and increased during its decline. A *febrile albuminuria* is quite common, and the sediment may show an excess of renal epithelium, a few blood-cells, and occasionally renal casts.

Acute nephritis may develop as a complication in the earlier or later course of the disease, and can be recognized to a certainty only by a thorough appreciation of the urinary phenomena. The urine is diminished in quantity, being often scanty, and there may be retention. It contains characteristic morphologic elements (albumin, casts, blood, and epithelium). The development of the *typhoid state* in this affection is rendered much more probable in the presence of this complication, and, moreover, uremic symptoms often put in an appearance at this juncture, and then the situation is really serious. Acute nephritis may arise at one or other of three different periods, and its significance varies with the time of onset: (a) at the beginning of the fever, when it often obscures the true nature of the malady; (b) in the early part of the fastigium or the second week of the disease. Coming on at this time—an event which I have observed in two instances—it is probably to be ascribed to the local effect of the toxin upon the renal tissues. Both of my own instances proved fatal, and in both an autopsy was refused. Wagner has had 5 cases of recovery in succession, but the high mortality mentioned by Amat—10 deaths in 12 cases—is the more common experience. (c) Acute nephritis may arise as a sequel of typhoid, when there is almost invariably associated a decided edema. In this category of cases recovery is to be expected.

The *diazo-reaction of Ehrlich* was, at one time, considered a valuable diagnostic aid, but as it may be present also in acute phthisis, meningitis, measles, pneumonia, and other fevers, it is rarely employed at the present time.

The simple *urochromogen test* can take the place of the diazo-reaction when desired (*vide* p. 281). Svestka¹ found it positive in all of 52 cases of typhoid fever as early as the first week of the disease.

Diabetes mellitus is, in extremely rare instances, developed after typhoid. *Hematuria* has also been observed as a symptom of the hemorrhagic diathesis.

¹ *Wien. klin. Wchnschr.*, 1915, xxviii, 1054.

There is a posttyphoid, diphtheritic *pyelitis* in which the pelves and calices of the kidneys are the seat of membranous exudation, and later of erosion and ulceration. The urine generally contains blood and pus.

Simple *vesical catarrh* may rarely result from catheterization for retention. *Typhoid cystitis*, in which the bacilli are found in pure culture in the urine, is not rare (*vide* p. 47). It occurs principally in patients who are predisposed by local conditions.

Orchitis, *epididymitis*, *spermatocystitis*, *prostatitis*, and *ovaritis* are occasional sequels. Blumenfeld collected 69 cases of orchitis; it generally develops suddenly during convalescence.

(h) **The Joints.**—Typhoid, septic, and rheumatic arthritis may occasionally arise as a complication. The first is usually *monarticular* (particularly in the hip); the last two commonly *polyarticular*. Keen has collected “in all 84 cases involving the joints.”

(i) **The Bones.**—*Periostitis*, due to injury and muscular strain and often leading to *necrosis*, is a not rare sequel of typhoid. The favorite seats are the tibia and ribs, though in a case of my own at the Philadelphia Hospital it affected the os calcis. Ebermaier found the *Bacillus typhosus* in the pus from 2 cases of suppurative posttyphoid periostitis, although other bacilli (streptococci, staphylococci, pneumococci) are at times associated. *Osteomyelitis* may also occur. Keen has collected 216 cases in which the bones were attacked.

(j) **The Muscles.**—As in the case of the heart, so the voluntary muscles exhibit hyaline degeneration; also abscesses, in consequence of secondary infection or of infection with the typhoid bacillus itself. Typhoid abscesses likewise result from perforations of the gut.

ASSOCIATED ACUTE INFECTIOUS DISEASES.—**Malarial fever** may be combined with typhoid, though the relationship is not a vital one. In an analysis of 2122 cases of malaria, typhoid fever was associated in 8 (Anders). Many instances of so-called typhoid-malarial fever, however, would be shown to be pure typhoid by a careful blood examination.

Pseudomembranous inflammation, as above intimated, may occur in the nasopharynx, larynx, gall-bladder, and genitals. *Measles*, *scarlatina*, and *chicken-pox* have also been known to arise in the course of, or during convalescence from, typhoid fever.

Erysipelas is a rare secondary affection coming on either during the height of the affection or (more frequently) after its close. *Typhus fever* may be associated with typhoid, but this is rare.

CLINICAL VARIETIES OF TYPHOID FEVER.—These are numerous, and may grow out of peculiarities manifested during the course of the affection, as may be observed not only in different epidemics, but also in the same epidemic. The groups of cases described here have reference particularly to the degree of severity of the type, which varies between the wide limits of extreme mildness, on the one hand, and extreme severity on the other. The course of the disease may also be modified by the occurrence of one or more of its manifold complications.

(1) **The Mild or Rudimentary Form (Typhus Lævissimus).**—Of this variety many cases occur, and especially among children. The spleen is almost always enlarged, the roseate spots are sometimes present, while the temperature is moderately elevated and often partakes of the same character as that of true typhoid. The fever, however, may pursue the remittent type. Complications presented by special organs are usually absent, but grave accidents (intestinal hemorrhage, perforation) are not impossible.

The *diagnosis* is always difficult, owing to the feeble development of the characteristic symptoms, and in the total absence of the latter is out of the

adynamia and serious danger from certain complications, such as pneumonia, nephritis, coma, cardiac exhaustion, and the like.

The diagnosis is difficult, owing to the prominence of the nervous and pulmonary symptoms, on the one hand, and the frequent absence of the more characteristic symptoms of typhoid on the other.

Diagnosis.—Unless all the chief characteristic features be present with a clear history, it is a golden rule not to make a positive diagnosis. Obviously, then, the physician at the first visit, often about the close of the first week, cannot, in many cases, diagnosticate typhoid with absolute certainty. If the case have been a typical one, the history of the gradual development of the disease, marked by such symptoms as languor, anorexia, headache, dulness, slight chills, increasing fever, and sometimes nosebleed, will be obtained, and justify a strong suspicion of typhoid. When, in addition, diarrhea and the objective symptoms, splenic enlargement, dry bronchitis, leukopenia, tympanites, gurgling, with tenderness in the ileocecal region, are present, the diagnosis of typhoid is made highly probable. After the lapse of a few days—the beginning of the second week—the roseate spots usually appear. The most certain method of making an early, positive diagnosis is by an examination of the blood for the *Bacillus typhosus*. The usual technic employed is first to sterilize the skin overlying and in the immediate vicinity of the median basilic vein with tincture of iodine; a compress or a bandage sufficiently tight almost to obliterate the radial pulse is put on the upper arm in order to make the vein stand out prominently; a needle of rather small caliber is then introduced into the vein, and as soon as the blood begins to drop from the end, a sterile glass syringe, capable of holding 20 to 25 c.c., is fitted to the needle and filled by aspiration from the vessel. One half of the blood is mixed with about 250 c.c. of 10 per cent. ox-bile broth, and the other half mixed with 200 c.c. of agar and plated. If a growth occurs in the media, subcultures are made in the usual culture-media used to determine the cultural characteristics of the organism. Likewise the agglutinative properties are studied with the blood-serum from a known case of typhoid or with antityphoid serum. The typhoid organisms may be recovered from the urine or stool by appropriate cultural methods in some cases in which other methods of diagnosis have failed. In obscure cases the occurrence of intestinal hemorrhage or a characteristic decline by lysis is helpful. To show a causal relation between an obscure case and one that is clearly typhoid leaves little to be desired. The diagnosis should include the particular stage of the disease. Briefly, the most trustworthy diagnostic features are the gradual onset, peculiar temperature-curve (made up of the “step-ladder” stage of development, the continued type of the fastigium, and the decline by lysis), enlarged spleen, the rose-colored spots, leukopenia with relative increase of the mononuclear cells, cultural experiments, and the seroreaction. The atropin test is highly spoken of by the English, who base their opinion upon the antagonism which apparently exists between the toxins of typhoid bacilli and atropin. The patient is given atropin, gr. $\frac{1}{30}$ (0.002), hypodermically at least one hour after eating and while in the prone position. The pulse is counted minute by minute one-half hour after the injection. Normally there should occur a rise of at least 15 beats per minute from the rate preceding the administration of the drug. This increased rate is absent in the presence of infection of the typhoid group.

Serum Diagnosis.—The results of the investigations of Pfeiffer and, later, those of Grüber and Widal have given us a specific seroreaction. The principle of the reaction depends upon the presence of agglutinins in the blood-serum of one ill with typhoid, which will cause clumping or agglutination of *Bacillus typhosus* when the proportion of serum to culture is 1 to 10 or more.

vaccine a Widal reaction is of no diagnostic value. It may be possible for the scene to be dominated by some other morbid process (tuberculosis, etc.). Again, exceptional cases occur with no reaction throughout. Brill has reported 17 cases of this sort; in such cases, however, the examination must be repeated until after convalescence is completed.

Chantemesse¹ suggests an *ophthalmic reaction*. It consists of the instillation into the conjunctival sac of a solution of "typhoprotein" ($\frac{1}{3}$ to $\frac{1}{2}$ milligram). The typical reaction is developed in six hours as a deep congestion of the lower lid and the caruncle. The *cutaneous reaction* is a more simple test and "gave positive results in every case in which it was employed" (Deehan).

DIFFERENTIAL DIAGNOSIS.—(1) **Typhus fever** in its epidemic form is to be differentiated by its sudden onset, by the deeper stupor, the besotted expression of the features, the injected conjunctivæ, the contracted pupils, the appearance on the fourth day of maculæ which are transformed into petechiæ; by the shorter course, the termination by crisis, and the absence of the Widal reaction. The milder type, described by Brill and others, endemic in the greater part of this country, offers greater difficulty in diagnosis than the severe epidemic form, but, as a rule, may be distinguished from typhoid fever by the more sudden onset, the low-grade leukocytosis, the more pronounced skin eruption, the blood-culture, and the negative Widal reaction.

(2) **Acute miliary tuberculosis** is to be differentiated from typhoid fever by the greater frequency of the pulse and respirations, the cough, and in some instances by the expectoration; by the diffuse cyanosis and the presence (sometimes) of choroidal tubercles. *Blood examinations* may show leukocytosis, but the mononuclears are not increased as in typhoid fever. There is an absence of the typical temperature-curve, the pulse, the characteristic eruption, and the Widal reaction and abdominal symptoms of typhoid. In doubtful cases lumbar puncture and blood-cultures should be undertaken, as tubercle or typhoid bacilli may be found.

(3) **Malarial fever** may assume the continued form of fever—*e. g.*, the æstivo-autumnal type, in which chills may be absent—and there are typhoids that affect both remittent and intermittent malarial fevers. Malaria can be differentiated from typhoid fever only by the detection of Laveran's hematozoa in the blood.

(4) **Relapsing fever** is distinguished by its abrupt onset, with rigor, high fever, pain in the epigastrium; by its brief duration, termination by crisis, and the occurrence of a relapse at the end of a week; by the absence of the characteristic eruption and the seroreaction of typhoid. The finding of the spirilla discriminates relapsing fever.

(5) **Meningitis.**—In striking contrast with the specific typhoid symptoms, meningitis exhibits marked hyperesthesia, intolerance of light and sound, exaggerated reflexes, and often muscular rigidity before the stage of effusion; also restlessness, peevishness (unlike the dulness observed in typhoid patients), vomiting, and constipation (*vide* Acute Miliary Tuberculosis). The temperature maintains a lower level on the average, and is more irregular in type than in typhoid; the pulse is more irregular, and the nervous symptoms assume greater prominence in the earlier stages, particularly headache and delirium. On the other hand, true typhoid symptoms are wanting in meningitis.

(6) **Tuberculous meningitis** gives a characteristic previous or family history, occurs in young subjects, and the tendon and cutaneous reflexes exhibit wide variations as to intensity within brief periods and throughout the whole attack. An examination with the ophthalmoscope may reveal choroidal tubercles. The Widal reaction is missing.

¹ *Progressive Medicine*, March, 1910, p. 186.

the chances for recovery. Improved methods of treatment in recent years have affected a decided lowering of the death-rate. Here it may be said that the average mortality rate of typhoid is from 8 to 10 per cent., as against 15 to 20 per cent. formerly. The death-rate was 2.3 per cent. lower among the inoculated South African soldiers than in the uninoculated, while still more recent figures show a marked decrease in mortality rate and morbidity severity in those that have had antityphoid inoculations. It must ever be remembered, however, that epidemics differ widely as to their mortality list—a fact which makes a precise statement regarding the question an impossibility.

(3) The third and last consideration is THE PRESENCE OR ABSENCE OF DANGEROUS COMPLICATIONS AND ACCIDENTS. These have all been enumerated and their prognostic significance stated (*supra*). Merely to reiterate some of those that lend fresh peril to the typhoid patient, arranging them with some regard for the order of their relative gravity, may prove helpful to the student. They are: perforation with diffuse peritonitis, intestinal hemorrhage, lobar pneumonia, lobular pneumonia, sudden collapse (due to cardiac weakness), excessive tympanites (often with marked diarrhea), and hypostatic congestion of the lungs. Intestinal hemorrhage occurred in only 6 per cent. of 266 typhoid patients who had been vaccinated (Yagisawa). Dublin has observed a marked increase in the number of tuberculosis deaths in surviving cases of typhoid.

RELAPSES OF TYPHOID FEVER

A relapse is a repetition of all the characteristics of typhoid after the latter has run its course. As a rule, the return occurs from one week to ten days after the beginning of convalescence, though it may be either earlier or later; and occasionally a relapse develops before the temperature has become normal (*intercurrent relapse*). The cause of relapses is a reinvasion of the blood by the typhoid bacilli or their secretions from within the body, and the source of the bacilli is most probably the gall-bladder. The *pathologic lesions* differ in no essential way from those described as belonging to the primary attack, but the stages through which they pass are not quite so long.

In the *interval* between the primary attack and the relapse there may be present suspicious features, such as a slight enlargement of the spleen, a trivial evening rise of temperature, and unnatural apathy or dulness, and a more profound prostration than is usual. In the majority of instances, however, there are no premonitory symptoms. The *onset* is rather more sudden and rigors are more common than in primary typhoid. The temperature, however, rises in the characteristic “step-ladder” fashion, reaching the fastigium in two or three days, and the same relative abridgment of the fastigium and defervescence is observed. It follows that a relapse has a shorter duration than a primary attack, and, indeed, it rarely exceeds two or three weeks. The temperature may, however, touch a higher limit in the relapse than in the primary attack; but, with rare exceptions, when the primary typhoid is of average or even greater than average severity, the temperature in the relapse does not reach an equal height. The characteristic rash appears earlier—from the second to the fourth day—and is somewhat darker and coarser than that of the first attack. The spleen swells rapidly. The *intercurrent relapse* sets in while the temperature is declining; the fever again rises, and often ranges higher than in the primary attack.

Diagnosis.—Upon the points that are distinctive of a primary attack of typhoid fever rests the important diagnosis between a relapse and a recrudescence (*spurious relapse*). The latter is usually attributable either to errors in

Gwyn has given the following results of his investigations into the question of typhoid bacilli in the urines of typhoid fever patients: They are present in from 20 to 30 per cent. of the cases, and may be exceedingly numerous. The organism may persist for months or years. For the disinfection of the urine in the bladder, hexamethylenamin is serviceable when administered by the mouth. Under no circumstances, however, should its administration permit the disinfection of the voided urine to be neglected. As an irrigation Gwyn recommends mercuric chlorid solutions (1 : 100,000 to 1 : 50,000). To disinfect the urine "the best solutions are: phenol (carbolic acid) 1 : 20, in an amount equal to that of the urine, or bichlorid of mercury 1 : 1000 in an amount one-fifteenth that of the fluid to be sterilized. These mixtures with the urine should stand at least two hours."¹

(a) It should be an invariable rule to change the bed- and body-linen daily, and as often as soiled. The mattress should be protected by a rubber cover, and this, together with the soiled linen and blankets, should be received in a sheet that has previously been dipped in a 5 per cent. solution of carbolic acid. The rubber sheets are to be washed with the carbolic acid solution, but all other bedclothes must be boiled for half an hour. When the patient leaves the sick-room the mattresses are to be fumigated and aired daily for a week, and the rubber covers and bedsteads washed with a solution of mercuric chlorid (1 : 1000).

(b) After every stool the patient should be cleansed with a compress of cloth or cotton wet with a solution of mercuric chlorid (1 : 2000) or of carbolic acid (1 : 40). The bed-pan and hopper are to be similarly treated, and the cloths used immediately burned. Fritz recommends that the feeding utensils be cleansed in boiling water after using.

In view of the significant rôle played by the bacilli carriers, convalescents must be regarded as dangerous until their urine and stools have been shown by laboratory methods to be free from typhoid bacilli. Junhan² advises four negative stool and urine cultures at intervals of six days. In Philadelphia typhoid fever is a reportable disease, and patients are not discharged from observation by the Health Bureau until three successive stools have shown the absence of the bacilli by cultural methods. Garbat³ advises cultures from duodenal contents (bile) removed by means of the duodenal tube as a more reliable and simpler method for the detection of typhoid bacilli than stool examinations. This method is also of value in detecting carriers who harbor the organisms in the gall-bladder.

Isolation of Patients.—It is advisable to isolate typhoid cases as far as possible—*e. g.*, in hospitals, to keep them in special wards; in private families, in special apartments—unless rigid precautions are taken by the attendants to cleanse thoroughly their hands after attention to the patient, to disinfect all material coming in contact with the patient, and, above all, to render innocuous the excreta. At the Johns Hopkins Hospital 1.81 per cent. of all cases are of hospital origin (Cole). Pulmonary complications, as pneumonia, demand isolation among typhoid ward patients, so as to prevent contagion by contact. Again, typhoid carriers should not be at large.

Prophylactic Vaccination.—The splendid results that have followed the inoculation of antityphoid vaccine have made such prophylactic treatment advisable for most dwellers, particularly those in early adult life, in cities or other congested localities. Among certain groups vaccination against typhoid is not only advisable but is very definitely and positively indicated. Such are

¹ *Jour. Amer. Med. Assoc.*, April 6, 1912, p. 1015.

² *Amer. Jour. Med. Sci.*, 1919, clvii, 608.

³ *Jour. Amer. Med. Assoc.*, November 18, 1916, p. 1493.

is less commonly employed at present than formerly; it is of some value in combating unfavorable nervous symptoms due to the typhoid septicemia, and the time for commencing its use may be indicated first by the latter symptoms (*e. g.*, delirium, coma, tremor). The quantity to be administered must be regulated by its effects, since it may act injuriously, and even aggravate the symptoms, though this is seldom the case. Among other useful cardiac stimulants are camphor, caffein, or caffein and sodium benzoate hypodermically, and the preparations of ammonium. Stengel has recommended hypodermic injections of 1 to 2 grains (0.65–0.13) of camphor dissolved in 15 minims (1.0) of sterilized olive oil as a cardiac stimulant in typhoid fever. Threatened collapse may be met by full doses of alcohol ($\frac{1}{2}$ ounce—16.0—every hour), combined with strychnin (gr. $\frac{1}{15}$ —0.004—every three hours), exhibited subcutaneously till the depression has been counteracted. In some cases adrenalin or pituitrin are most efficacious as temporary stimulants in circulatory collapse. One hundred c.c. of salt solution into which 1 c.c. of adrenalin has been mixed is given directly into the vein, care being taken to allow the fluid to run in very slowly. Effective doses of diffusible stimulants, as champagne, are useful during periods of sudden circulatory depression. Strophanthin intravenously or some digitalis preparation for hypodermic use are extremely valuable cardiac stimulants to combat this symptom.

(4) **Hydrotherapy.**—There is at the present day general agreement among medical authors that the best mode of treating typhoid fever is by means of hydrotherapy. The beneficial influences of hydrotherapeutic procedures are as follows: (1) They absorb the body heat directly, thus reducing the temperature and overcoming the ill effects of high fever, this action becoming more marked after a day or two of the treatment; (2) they improve the nervous symptoms, diminishing mental dulness, delirium, stupor, muscular tremors and twitchings, and inducing sleep; (3) they strengthen the heart, thus obviating the danger of sudden circulatory collapse and the consequences of increasing cardiac weakness (hypostatic congestion of the lungs, venous thrombosis, etc.); (4) they stimulate the respirations, whereby the inspirations are deepened and the tendency to pulmonary complications greatly lessened, especially severe bronchitis, lobular pneumonia, etc.; (5) the renal function is invigorated, and as a result the elimination of typhotoxins by the kidneys is increased (Roque and Weil); (6) on account of the cleanliness of the skin which they ensure bed-sores rarely occur; (7) they may shorten the stay in the hospital or sick-room, but not the stay in bed, except, perhaps, in the lighter types.

The *contraindications* to the use of active hydrotherapeutic measures are: (1) *Intestinal hemorrhage*, which is in itself attended with danger and requires absolute quiet for a time (four days), when the baths may be resumed if there is no recurrence. (2) *Peritonitis*, the occurrence of which always excites suspicion of perforation. Here, again, rest and all that the term implies must be procured. (3) *Extreme Cardiac Weakness.*—This condition is sometimes met with in cases that come under observation at a late period, and in cases arising in aged and enfeebled subjects. (4) Cases that have progressed to an advanced stage (the third week of the disease) should not be immersed. Dangerous and even fatal collapse has been observed to follow cold baths under these circumstances.

Methods.—The cold tub treatment as suggested by Brand, in which the patient is placed bodily in a tub of cold water, has been largely discontinued, at least in this country, on account of the extreme discomfort to the patient, the necessity of special apparatus, and the need of at least two assistants. In consequence of these facts substitutes for the tub baths are quite commonly in vogue. Among them, cold sponging of the body of the patient is often

(8) **Treatment of Individual Symptoms and Complications.**—*Headache.*—Early in typhoid the headache demands relief. Absolute rest and cold to the head frequently suffice. Depressant analgesics are to be avoided so far as possible, although it sometimes becomes necessary to resort to them. At such times those least objectionable are to be selected. I have found that a mixture containing sodium bromid (gr. x to xv—0.65–1.0) and the deodorized tincture of opium (℥ij to v—0.2–0.3) in each dose, given at intervals of three or four hours, exercises a striking palliative influence. In occasional instances the above mixture fails, and then phenacetin (gr. ij to iij—0.13–0.2) may be substituted for the opium in the same combination.

Insomnia.—The cold baths or other measures calculated to relieve the headache often procure for the patient refreshing sleep. It is important not to allow him to go too long without sleep, since this tends to the development of a pronounced “typhoid state” and its concomitants. When the agents recommended for the headache fail, I employ morphin hypodermically in small doses (gr. $\frac{1}{8}$ to $\frac{1}{4}$ —0.004–0.008) during the evening hours, withdrawing the remedy so soon as decided amelioration of this symptom has taken place. Codein, veronal, trional, and chloral have proved useful.

Delirium.—Since the introduction of hydrotherapy delirium rarely calls for special medication. I have observed, in common with others, particularly during the advanced stages, that in cases in which the circulation was feeble and in which typhomania was a prominent feature, the administration of stimulants with a free hand completely dispelled the nervous phenomena. If alcohol fails, ether (℥x—0.6—at a dose) may be given hypodermically, and repeated in one or two hours if necessary. Of special value are the bromids, hyoscin hydrobromid, and the persistent use of ice to the head.

Vomiting is rarely troublesome. Its chief cause is the irritation of the gastric mucosa from improper diet or medication. After the removal of the cause, the use of ice in small pieces by swallowing affords relief. If vomiting occurs during the period of development, minute doses of calomel, combined with sodium bicarbonate, may be prescribed with good effect. If it occur during the fastigium, the amount of milk taken should be reduced by one-half, peptonized, and then diluted, preferably with lime-water. If the patient experience a strong aversion to milk, it must be suspended temporarily and albumen-water and broths substituted. Dry champagne may be administered simultaneously.

Diarrhea more than any other single symptom claims special attention. Two to four movements daily do not constitute diarrhea and do not demand treatment. It may be caused by overfeeding or by improper food—as shown by the stools, as a rule—in which case regulation of the diet is curative. It is often due to ulcerated and catarrhal lesions of the intestines, and particularly the large. Unquestionably, intestinal antiseptics which possess the property of insolubility are most valuable. Astringents may be combined with the latter or given separately. The subjoined formulæ have yielded good results in my own hands:

R. Betanaphtholis, 3j (4.0);
Bismuthi subgall., 3ij (8.0).

M. et ft. caps. No. xxiv.

Sig. One every two or three hours.

Or,

R. Plumbi acetatis, gr. xxiv (1.5);
Phenylis salicyl., 3ss (2.0).

M. et ft. caps. No. xij.

Sig. One every three or four hours, as required.

Large doses of bismuth (gr. xxx—2.0) every third hour are useful.

Late in typhoid fever, when the ulcers are fully developed, opium is of service; it tends to arrest the peristaltic action. When distention is increased by the use of opium it is to be omitted. I have recently observed brilliant results from the use of rectal injections of an astringent solution (tannic acid 1 to 2 per cent.), alternated with an antiseptic solution (salicylic acid 1 to 2 per cent.), each given once daily.

Constipation is to be relieved by simple enemata of soapsuds every second day. Calomel may be used in the early stage of dynamic cases. Its employment may be followed by symptoms of a milder type than are ordinarily encountered. If constipation exists during the third week, accompanied by an oscillating temperature-curve, saline laxatives in small but repeated doses may cut short the attack. These failing, however, liquid paraffin (f3ss to j—15.0–30.0) at night deserves a trial.

Tympanites.—This is sometimes a most distressing symptom, and treatment should be commenced early. As a remedy for tympanites turpentine richly deserves a trial, but it does not, as some claim, influence the general course of the disease. When employed for this symptom alone I prefer to apply it in the form of stupes over the abdomen, although when the gases occupy chiefly the large bowel, turpentine enemata should be given. Irrigation of the colon with the normal saline infusion has proved effective in relieving tympanites. Eserin, gr. $\frac{1}{100}$ (0.00065), every third hour, administered hypodermically, sometimes proves efficient.

The meteorism is often increased by the milk taken, and a change of food to meat juices and albumin-water may be tried.

Hemorrhages.—The bowel movements, if the hemorrhage has been copious, must be allowed to pass into the draw-sheet. The ice-bag (suspended if possible) should be applied to the right iliac region, and ice freely given by the mouth. Morphin, to control peristalsis, must be given, and, by preference, hypodermically. It may be supplemented by full doses of the acetate of lead. Cases in which slight oozing appears from time to time require turpentine. The amount of food should be greatly restricted, and in serious bleedings abstinence from food for from twelve hours to three or four days is to be observed. When feedings are resumed, a teaspoonful or two of cold milk (repeated every two hours) may be given during the first twelve hours, then gradually increased in amount. For severe hemorrhages, *saline infusion*, either by the method of intravenous injection or by hypodermoclysis or enteroclysis, is to be strongly advised. The depleted volume of the circulation may be restored and maintained by its use, administered either intravenously or subcutaneously. The proper strength is 8 : 1000, and from 10 c.c. (3 fluidrams) to $\frac{1}{2}$ liter may be employed if the collapse is marked, and repeated several times in the course of a day. Rectal injections may be somewhat larger. McCrae advises calcium lactate in doses of 20 grains a day; it may be given subcutaneously, if rapid action is desired, in a 1 per cent. solution. Calcium salts are indicated where the coagulation time is slow. In case the blood gives a poor agglutination reaction, phlebotomy to the extent of about 10 ounces (according to the physical condition of the patient) may be tried. On the other hand, with the patient *in extremis*, transfusion may prove effective.

Peritonitis.—While the treatment of perforation is surgical, opiates are indicated as soon as perforation has taken place, and according to Eddy operation offers some hope of cure, and with the progress of convalescence the chances of recovery from this accident improve. Deaver regards the acute development of pain and generalized abdominal rigidity and tenderness as an urgent indication for immediate celiotomy. Keen's statistics show that between twelve and twenty-four hours after perforation is the most favorable

time for operation, this period giving 30 per cent. of recoveries. Le Conte holds that it should be immediately undertaken. Rarely, appendicitis supervenes in typhoid fever. It demands prompt removal of the appendix.

Lobar Pneumonia.—Its treatment, when a complication, will be considered hereafter (*vide* Secondary Pneumonia).

The *hypostatic congestion of the lungs* is to be met by heart stimulants and by frequently changing the position of the patient.

Bronchitis.—No special measures are necessary unless the bronchitis is both diffuse and severe, when its management is like that of *bronchopneumonia* (*vide* p. 127).

Laryngitis.—For this condition counterirritation should be tried; and if this fails, a small blister may be applied below the angle of the jaw on either side. For edema of the larynx scarification and the inhalation of steam are useful measures. Then, should suffocation become imminent, tracheotomy should be performed without delay. Operation "gives a mortality of only 55.5 per cent." (Keen).

Bed-sores.—The preventive measures have already been considered. The smallest bed-sore demands active treatment. It is to be kept clean and dusted with a powder composed of equal parts of boric acid, calomel, and bismuth; if sluggish, with a powder of aristol and iodoform.

Thrombosis of the femoral vein is best treated by elevating the part and keeping it at perfect rest. An ointment composed of equal parts of unguentum ichthyol (12 per cent.), lanolin, and unguentum belladonna may be applied along the course of the affected vessel thrice daily.

(9) **Management of Convalescence**.—Some of the points connected with this subject have already been discussed (*diet, time for getting up, etc.*). I may add that should a recrudescence occur the patient should be kept at rest in the recumbent posture and a return made to the previous food. Often a laxative serves a good purpose, particularly if an indiscretion in diet has been committed. The ulcers may not be healed, though the temperature may have been normal for a week or ten days; hence the patient should not be allowed to stir about for a period of two weeks after the temperature has become normal. At first his movements should be slow; he may soon, however, be allowed to exercise gently in the open air during seasons of favorable weather. Mental excitement is to be avoided. Occasionally during convalescence the diarrhea persists, being due to colonic ulceration, and is best treated by restricting the diet to milk and other fluid forms of food. The patient must be confined to bed. Medicinal treatment by the oxid of zinc internally and the use of astringent and antiseptic rectal injections, as before indicated, usually proves successful. Constipation is best relieved by simple enemata. Most patients require tonics. We should begin with a vegetable salt of iron in combination with a simple bitter (*e. g.*, infusion of gentian), and later an inorganic salt of iron, with quinin and strychnin, may be used. Relapses are to be treated as primary attacks.

PARATYPHOID FEVERS

This term is applied to a group of affections that closely simulate typhoid fever clinically, but are due to different microbic causes.

Pathology.—The anatomic changes are simply those of septicemia with splenic swelling and occasionally non-specific ulcers in the intestines. H. G. Wells and L. O. Scott have summarized the pathologic findings of 5 cases of paratyphoid and concluded that its pathology is different from that of ordinary typhoid. There are slight, if any, changes in Peyer's patches or the solitary follicles. The mesenteric glands show alterations, and focal necroses have been noted in the liver.

COLON BACILLUS INFECTIONS

The group of colon bacilli, as previously mentioned, is closely related to those intermediary between themselves and the typhoid bacillus, of which the paratyphoid bacillus is the type. Our knowledge of the pathologic lesions excited by the *Bacillus coli* is quite imperfect, but a division into (1) local and (2) general infections is recognized.

(1) **Local Infections.**—(a) *Peritonitis*.—Following perforation of the intestines, but also in cases in which this has not occurred, peritonitis may be excited by the *Bacillus coli*. Although in most cases a general peritonitis, it may be local as well.

(b) *Cholecystitis and Cholangitis*.—Both catarrhal and suppurative types. The usual symptoms attend these lesions (local tenderness, leukocytosis, etc.). Hepatic duct infection with jaundice, tenderness, leukocytosis, and persistent fever may be caused by the *Bacillus coli*.

(c) *Infection of the Urinary Tract* (Common).—Pyelitis, commonly secondary to other infections (typhoid, pregnancy or puerperium, etc.), is not infrequent. The method of infection is chiefly through the lymphatics, which explains its more frequent occurrence in the right than the left kidney, since there is a lymphatic connection between the former and the cecum and ascending colon. Cystitis may be associated.

(d) Such intestinal affections as appendicitis, duodenal ulcer, dysentery, and diarrhea are probably due to *Bacillus coli*, in some instances at least.

(e) Acute meningitis, endocarditis, and suppurative foci may rarely be *Bacillus coli* infections.

(2) **General Infections.**—These may be either acute or chronic in type. The acute form may bear a close likeness to typhoid fever. The acute general infection may be followed by local abscesses (*e. g.*, renal). General infection with the colon bacillus may develop near the close of some chronic complaints. On the other hand, Adami suggests that many chronic diseases are produced by a mild, continuous infection with the *Bacillus coli*—*e. g.*, anemia, hepatic cirrhosis.

Diagnosis.—The symptoms, however well marked, have little evidential value, an assured diagnosis demanding cultural isolation of the *Bacillus coli* in all cases or positive agglutination tests.

The *treatment* is that of other general infections. The removal of local foci may be called for, if accessible. In involvement of the urinary tract the use of urinary antiseptics (*e. g.*, hexamethylenamin), large amounts of water, and suitable local measures are recommended. The vaccine treatment may also be carried out in cases early recognized.

TYPHUS FEVER

(*Ship-fever, Camp-fever, Jail-fever, etc.*)

Definition.—An acute contagious disease caused by the *Bacillus typhi-exanthematici*. It is characterized frequently by an abrupt invasion, and is marked by rigor, high fever, early nervous symptoms of great prominence, a maculopetechial eruption appearing between the third and fifth days, and a termination by crisis.

Historic Note.—In 1759 the name *typhus* was proposed by Sauvages. In presanitary times it prevailed in epidemic and endemic forms, particularly

crowding. It prevails in jails and camps. Other factors are of little importance, because if an individual is present where body lice abound and he is bitten by an infected louse in all probability he will get the disease, no matter what his age, station in life, sex, or other similar conditions may be.

Epidemics occur oftenest in winter, owing to the closer and more confined life and association of the poorer classes. Extreme heat is detrimental to the life of the louse, and therefore epidemics are rare in summer. Typhus almost invariably prevails in an epidemic form.

Clinical History.—Incubation.—This lasts from seven to eight days. There may be prodromal symptoms, such as anorexia, general malaise, etc., but in most instances *invasion* is sudden.

Pre-eruptive Stage.—The *early* symptoms are either a series of chills or one severe rigor, accompanied by vertigo, tinnitus, headache, muscular pains, profound prostration, and fever. The *temperature* quickly ascends to a high level, reaching 104° or 105° F. (40° or 40.5° C.) as early as the second or third day. The fever is continuous in type, and in severe cases a serious systemic condition may often be developed. The *pulse* is accelerated proportionately to the temperature and is of good volume. Bronchitis may be present, the appetite is lost, and the thirst is excessive, while a thick, yellowish-white coating covers the tongue. *Vomiting* occurs, and may be a prominent symptom. The *urine* is often scanty, its specific gravity is increased, and it may contain a trace of albumin. The diazo-reaction may be obtained; it usually disappears shortly before the crisis. The cheeks are flushed and the eyes are injected.

Nervous symptoms appear early—often at the very onset—and are quite pronounced. At first there may be either mild or active delirium, but soon there is stupor or even coma, and the face takes on a dull, stupid, besotted appearance. The spleen is generally enlarged.

Eruptive Stage.—Between the third and fifth days of the invasion the *characteristic eruption* appears *without an accompanying decline in the temperature*. The *rash* comes out first upon the trunk (chest and abdomen), extending thence over the rest of the body, but, strangely enough, often sparing the face. The crimson-red maculæ are changed in two or three days to a darker hue (petechiæ), and when coalescence occurs we have the spotted effect that has caused the name of *spotted fever* to be given to it. This name is also given to cerebrospinal meningitis, in which the eruption does not appear at any given time. Not all of the maculæ are converted, but some may remain as rose-spots, particularly in mild forms of typhus, and these disappear when pressed upon, while the petechiæ do not. The skin surface between the spots is sometimes diffusely hyperemic, and the eruption is usually rather abundant, though in well-authenticated cases it has been scanty or even wholly missing. The skin may also present darker and lighter blotches, producing a mottled appearance. In the stage of eruption the symptoms become aggravated in typical and severe cases. The temperature continues high, often reaching 106° F. (41.1° C.) or even higher, with slight nocturnal remissions. The pulse becomes quite rapid (120 to 140 or more), feeble, sometimes dichrotic and irregular, and the respirations increase markedly in frequency. At this time severe bronchitis, leading to *bronchopneumonia*, is apt to develop. The *tongue* is brown, fissured, tremulous, and occasionally black. Sordes form on the teeth and lips. The *urine* is scanty, high-colored, and often albuminous.

The *nervous disturbance* is intense, and may take the form of typhomania, leading to complete coma or maniacal delirium. The patient often lies with eyes open, staring into space, yet unconscious (*coma-vigil*). The motor nerves show derangement (tremors, subsultus tendinum). The decubitus is dorsal;

the flushed cheeks become dusky, the face expressionless, and the pupils often contracted. The prostration reaches an extreme degree, and absolute exhaustion often terminates life. Lumbar puncture shows the fluid under considerable tension; the fluid is clear as a rule, but according to Danielopolu xanthochromia is frequently met with—in 58 of the 218 cases in which he examined the spinal fluid—and there is also a high leukocyte count (lymphocytosis). Meningeal reaction did not occur without serious nervous disturbance.

As a rule, in favorable cases the end of the febrile period comes by *crisis* between the fourteenth and seventeenth days of the disease. Immediately preceding the crisis there is generally a sudden rise of the temperature (*perturbatio critica*). The occurrence of the crisis is marked by rapid improvement in the symptoms.

LEADING SYMPTOMS AND COMPLICATIONS.—Course of the Fever.—Although the temperature rises rapidly on the first day of the illness, the highest grade is usually reached as late as the fifth or sixth day. Hyperpyrexia usually heralds a fatal termination, the temperature mounting to 108°, 109° F. (42.7°, 40.0° C.), or higher, though in light cases the acme may not exceed 103° F. (39.4° C.). The temperature pursues the continued type and ends by crisis. Occasionally the fever declines by rapid lysis. About the beginning of the second week the patient emits a disagreeable odor that is regarded as characteristic by some writers.

The **lungs** frequently present complications (*vide* Pathology), among which are *bronchitis*, *bronchopneumonia*, and *hypostatic congestion*. Bronchopneumonia is dangerous, its development often preceding a fatal termination, and it may lead to pulmonary gangrene and empyema. Serofibrinous pleurisy and lobar pneumonia also occur as complications, and to recognize the latter the physical signs must be appreciated, the rational symptoms being in abeyance.

The **heart** in typhus continues to grow progressively weaker until, in many cases, a fatal issue is reached. This is manifested by the change in the character of the sounds. A systolic *murmur* (probably of hemic origin) may be audible at the apex. Myocardial insufficiency occurs in about 30 per cent. of all cases and varies with the severity of the disease. A bradycardia is common after the febrile period in patients who do not have signs of weakened myocardium. The blood-pressure is low, as a rule, and persists so for a long time after convalescence, particularly in those who have recovered from a severe attack.

The blood shows a leukocytosis which is greater and more pronounced the more severe the case. There is an absolute increase in all cells except eosinophils, which disappear during the febrile period, but with a relatively greater increase in the percentage of mononuclears than in the polymorphonuclears.

The **nervous phenomena** have been sufficiently detailed. *Meningitis* has been met with, but is rare as a complication. Arnold¹ noted optic neuritis in 8 out of 14 cases. *Hemorrhagic nephritis* rarely supervenes. During the febrile period the uric acid and urea increase in quantity, while the chlorids decrease.

The **digestive tract** rarely presents distressing symptoms and complications. *Hematemesis* is most common, and *cancrum oris* has been noted occasionally. Cases in which the mouth does not receive proper care are apt to develop *parotitis*, which often passes on to suppuration, and *septic processes*, causing abscesses in different parts of the body (joints, subcutaneous tissue), may arise as complicating events.

Among the **sequelæ**, *neuritis*, followed by *paralysis*, deserves first place, and *gangrene of the extremities* (toes, fingers) has been observed.

¹ *Wien. klin. Wchnschr.*, August 17, 1911.

Clinical Types.—*Rocky Mountain spotted fever* is nowadays generally considered to be a type of typhus fever. Wolbach¹ states that the specific lesions of this disease are practically restricted to the blood-vessels of the skin and genitalia, and that they are caused by the minute parasite he previously has described. An extremely extensive study of this disorder has been made.² He considers the causative organism to be a parasite which he has named the *Dermacentroxenus rickettsi*. This disease is transmitted by the wood tick, and most of the epidemics have been characterized by their mortality rate. For example, in the Bitter Root Valley, according to Anderson, 84 of 121 cases were fatal. The general clinical course of the disease, as well as the symptoms, is essentially identical with the severe forms of typhus. The treatment is the same.

The **general course and duration** of typhus are variable. There is a mild type, the so-called *Brill's disease* (*vide supra*), which is characterized by sudden onset, with chill and severe headache, a rapid rise in temperature which may persist around 103° to 104° F. for ten to fourteen days, to fall by rapid lysis; the appearance of an eruption on the fifth or sixth day, somewhat suggestive of the rose-spots of typhoid, but which is more general and more wide-spread than the eruption of typhoid, does not appear in crops nor disappear on pressure, and is maculopapular in character. There is also a slight leukocytosis and a negative Widal and blood-culture. In this type the development of serious symptoms or grave complications is the exception. The Manchurian typhus of the far East runs a course similar to that of Brill's disease. Mexican typhus, *tabardillo*, on the contrary, is usually a severe, virulent type of typhus. A *malignant type*, however, also occurs (*typhus siderans*), and this often proves fatal before the time for the appearance of the rash. In Japan a disease known as *totsugamushi disease*, conveyed by the bite of a parasitic insect whose host is the field mouse, has marked similarity to typhus fever. Clinically the disorder resembles closely typhus fever, but immunologic studies throw considerable doubt as to the truth of the generally accepted idea that the two diseases are identical.

Some epidemics are characterized by the relative frequency of light forms, and others by the severer types of the disease.

Diagnosis.—On the known presence of an epidemic, the special causative factors (unhygienic surroundings, exposure to the louse) and the course and characteristic symptoms, the diagnosis of typhus fever can be made. Of special value is the eruption—its time of appearance (third to fifth day), mode of distribution, and petechial character. The recognition of lighter types, on the one hand, and malignant, on the other, is not possible from the symptoms alone, but here a knowledge of the existence of an epidemic in the vicinity is often helpful. Craig and Fairley³ claim that the agglutination test is an invaluable aid in the diagnosis of typhus.

Differential Diagnosis.—*Cerebrospinal meningitis* may be distinguished by a more intense headache, by retraction of the head, hyperesthesia, intolerance of sounds, photophobia, palsies of the eye-muscles (strabismus), a tendency to convulsions, and by both the absence of the typhus eruption and the expressionless countenance. Quincke's lumbar puncture may be practised.

Uremia is excluded by the previous history, the vomiting, headache, convulsions, coma, and by the absence of the high temperature and petechial eruption of typhus. Characteristic urinary phenomena are associated in uremia, and rarely *acute hemorrhagic nephritis*.

¹ *Jour. Med. Research*, 1918, xxxvii, 499.

² *Ibid*, 1919, xli.

³ *The Lancet*, London, September 21, 1918, p. 385.

The eruption of *malignant measles* may bear a close resemblance to that of typhus; the rash in typhus, however, appears first upon the trunk; that of measles, upon the face. Koplik's spots do not appear in typhus. Points connected with the epidemicity of measles, as the occurrence of mild and typical cases, must be taken into account. *Typhoid fever* is readily differentiated from typhus (*vide* p. 43).

Relapses are among the rarest of clinical events, and one attack, as a rule, bestows immunity for life. This immunity commences a few days after the disappearance of the fever, according to Nicolle.

Prognosis.—To arrive at a correct prognosis it is necessary to consider (1) the degree of severity of the particular type from which the patient is suffering, (2) the number and character of the complicating conditions present, and (3) circumstances connected with the individual, among which his food-supply and sanitary surroundings are to be recollected. Improved sanitation has reduced both the incidence and mortality rate, which is now between 10 and 20 per cent.

Treatment.—This embraces, in the main, the same principles that were found to govern the treatment of typhoid fever.

Prophylaxis.—The disease is transmitted by the body-louse. Measures to prevent the disease therefore depend upon prevention of infected lice reaching the individual. In the Balkans, during the Great War, the clothing of lice-covered soldiers, upon their return to the bases, was burnt or boiled and the body thoroughly washed with petroleum, the most efficient insecticide for the destruction of these small animals. When lice were encountered in the field, powdered naphthalin was given to the soldiers to powder on the body. The men sick with typhus were isolated, their bodies anointed with a petroleum ointment or a 5 per cent. naphthalin ointment, and other measures taken to prevent lice biting the infected individual and carrying the disease to healthy persons. Delousing plants were in full operation at all Allied and German bases during the war. Soldiers returning to America were not only carefully examined for body lice before returning and on returning to this country, but, as an additional precaution, were "deloused" on both sides of the sea before being allowed to mingle with the civil population. Particular attention was paid to the clothing, as it is in the clothing that the lice live and breed.

The **general management**, including the use of stimulants, in this disease does not differ from that advised in typhoid fever. Fresh water should be given freely at regular intervals. *Hydrotherapy* constitutes the best means at our command for controlling the temperature and the nervous symptoms. Danielopolu had splendid results with morning and evening intravenous injections of 500 c.c. of 65 per cent. salt solution. The injections should be continued until the symptoms are markedly relieved. In addition, the use of antiseptic agents and tonic measures are to be recommended. The fact that typhus is a self-limiting affection gives those measures that are intended to combat exhaustion, and especially heart weakness, first rank in the treatment of this affection. Strychnin (gr. $\frac{1}{40}$ —0.0015) and camphor in sterilized oil (gr. ij—0.13); one or both may be given hypodermically every third hour if there be failure of the circulation. A vaccine prepared from Plotz's organism is now on trial; it seems to exert a tendency to abort the disease, but apparently has only slight therapeutic value. Nicolle and Blaizot found that under serotherapy defervescence occurred from the sixth to the twelfth day in a number, and the average for all was 11.61 days. The dosage ranged from 10 to 20 c.c. a day by subcutaneous injections. The virus, heated to 50° C., cannot cause the disease, nor can it confer immunity, rendering improbable the possibility of successful vaccination.

DYSENTERY

Definition.—An infectious inflammatory disease of the large intestine, characterized anatomically by ulceration of the intestinal mucosa, and clinically by frequent mucous and bloody discharges, tenesmus, fever, and prostration becoming profound. It is a truly epidemic disease, yet it also occurs constantly in endemic form, and particularly is this true of temperate climates.

Varieties.—Etiologically considered, two varieties are recognized: (1) bacillary and (2) amebic. Under bacillary dysentery a description of the sporadic form (catarrhal dysentery) will be given.

Historic Note.—Few diseases have been longer known than dysentery, of which we have a description by Hippocrates. Galen localized the chief seat of the affection in the colon, and in 1626 Sennertus defined its sporadic character and some of its leading clinical features. To Morgagni belongs the credit of having made the first postmortem anatomic study of the disease. Further and more accurate pathologic contributions were made in the earlier part of the present century by Cruveilhier and Rokitansky, and, more recently still, the whole subject of the morbid anatomy of this disease has been carefully investigated by Virchow, whose results have settled most of the questions connected with the subject. In the United States dysentery has prevailed epidemically upward of a century, the time of greatest prevalence in different districts having been about the middle part of the present century (1847–55). Woodward has given us the only complete record of the various outbreaks in this country, and an account of the ravages of dysentery in both armies during the War of the Rebellion is given in his *Report*, which records 259,071 cases of acute and 28,451 of chronic dysentery. The disease is far less frequent than formerly, owing to the advance made in recent times in sanitary science.

Etiology.—A few general considerations, having reference to the causation of the different forms in common, may be adduced here.

Among **predisposing factors**, *season* heads the list, dysentery being most common in the summer and autumn. *Climate* has a marked effect, and high temperature must be regarded as a powerful agency, since the disease is much more prevalent in warm than in cold climates, though it is met with in epidemic form as far north as Norway. *Unhygienic conditions*, as shown by the local epidemic outbreaks in armies, jails, barracks, institutions, etc., predispose to the affection. All these factors are probably of importance due to the fact that flies, the great carriers of the organism, are bred in largest numbers in the summer and early autumn; hot weather is the ideal breeding season for flies; and in armies, institutions, and such places there is always a large amount of excreta to be disposed of, frequently unhygienically, upon which flies may alight and carry the germs away with them.

Among factors connected with the individual are: (a) *Catarrhal* conditions of the intestinal tract, particularly if this be caused by unripe fruit or other unwholesome forms of food; (b) *Age*: Although no age enjoys immunity against dysentery, most cases are met with in adults under thirty-five years. *Sex* and *race* are probably without appreciable influence.

(1) BACILLARY DYSENTERY

(Acute Dysentery)

This term is appropriately applied to the usual acute epidemic form of the disease. I shall describe here two clinical types: (a) catarrhal dysentery and (b) diphtheritic. It is not proved that all of the cases of bacillary dysentery are due to a common micro-organism—the Shiga bacillus (*Bacillus dysenteriae*). On the contrary, among the American troops fighting in the Chateau-

There will usually be tenderness over the line of the colon, but there is an absence of tympanites.

The *general symptoms* are well marked only in the severer types. The patient is debilitated, sometimes even collapsed, as shown by the small, frequent pulse, cool skin surface, the rapid wasting, and weak, hoarse voice. The temperature is not much elevated, though it may touch 103° or 104° F. (39.4° or 40° C.), and the curve is an irregularly remittent one.

Diagnosis.—This can easily be made upon the intestinal features and from the character of the stools—frequent, small, slimy (or bloody) discharges, accompanied by distressing tenesmus.

Differential Diagnosis.—Symptoms simulating dysentery may appear in the course of certain rectal affections, such as *strangulated hemorrhoids*, *sypilis*, and *epithelioma*. In these conditions there is a different history and the symptoms of proctitis are less acute, while a physical examination of the rectum will settle the diagnosis in doubtful cases.

Prognosis.—The *duration* of mild cases is from eight to ten days, and in severe types from three to four weeks. The *prognosis* varies according to the type of the affection; but commonly this is not aggravated and recovery is to be expected. Occasionally, however, the disease is threatening to life. Serious nervous symptoms (delirium followed by coma) may develop and cause a fatal termination. When death occurs it is usually due to exhaustion, and is seen particularly in persons previously enfeebled by disease or in the very young and the aged. Complications influencing the prognosis are exceptional. This variety probably does not occur in extensive epidemics; but it prevails in tropical and subtropical countries, and also throughout Europe and North America.

(b) DIPHTHERITIC DYSENTERY

(*Acute Tropical Dysentery*)

Definition.—An intestinal inflammation (usually colonic), accompanied by a croupous, or true, diphtheritic exudation. It is epidemic in Japan, but prevails wherever large numbers of persons are closely associated, as in armies, asylums for the insane, ships, and the like.

Pathology.—In mild grades a grayish-yellow, croupous exudate appears upon the inflamed mucosa, with a necrosis of the epithelial layer that is often limited to the top surface of the folds of the colon. In other instances the diphtheritic infiltration involves all the layers of the bowel, which now becomes greatly enlarged, its mucous membrane being converted into a yellowish-brown, thick, elastic mass, sometimes extending along the entire length of the large intestine. The changes may be confined to the circumscribed areas (flexures of the colon and rectum), and thick sloughs may be cast off, leaving behind ulcers of corresponding size and depth. The morbid changes in some cases are principally ulcerative in character, simulating those described under Catarrhal Dysentery (*vide* p. 66). Indeed, the pathologic unity of the various forms of bacillary dysentery would appear to be almost established.

Bacteriology.—The distinctive pathogenic agent is the *Bacillus dysenteriae* discovered by Shiga during his investigations into Japanese dysentery. Flexner found the same organism. Duval, Harris, and Flexner have described different strains of the *Bacillus dysenteriae*, showing that decisive criteria of difference are observable, which separate this organism from the *Bacillus typhosus*. The *Bacillus dysenteriae* is not normally found in the intestines. The Shiga bacillus, however, "is inactive to blood-serum from typhoid cases, but reacts with serum from dysenteric cases to which *Bacillus typhosus* does not respond" (Flexner). It may be that a number of bacilli which closely resemble one another, yet different, are capable of causing epidemics of true

SECONDARY DIPHThERITIC DYSENTERY

Here the lesions are similar in kind, but less intense, as a rule, than those of the primary form. This variety is met with as a terminal condition in not a few acute and chronic diseases; it often occurs in pneumonia (Bristowe), and less commonly in typhoid fever. Among chronic affections, upon which this condition may become engrafted, are nephritis, organic disease of the heart, and pulmonary tuberculosis.

No characteristic *symptoms* attend upon its invasion. There may be slight diarrhea—two or four liquid stools daily—but it is not often accompanied by tormina and tenesmus, and the discharges rarely contain any noticeable amount of blood, mucus, or shreds of pseudomembrane. Secondary diphtheritic dysentery often induces fatal asthenia.

Sequelæ of Bacillary Dysentery.—In all forms a relapse is likely to occur, each attack increasing the liability of the patient to subsequent ones. Moreover, in persons who have recovered from acute dysentery we often observe a disordered digestion and irritability of the bowels. Rarely, chronic nephritis follows dysentery. The most interesting sequel, however, is paralysis, which occurs mainly in the form of paraplegia (S. Weir Mitchell). Stricture of the bowel is rare.

Treatment.—Prophylaxis.—This embraces isolation and a thorough disinfection of the discharges, which contain the specific germ of the disease, as soon as passed. It is known that a mild adult case may readily infect a baby, sometimes with rapidly fatal results. Hospitals should not admit bacillary dysentery unless they have the facilities for isolating these patients, and among precautions fly exclusion is important (Smillie). The drinking-water during the epidemic prevalence of dysentery should be thoroughly boiled, and healthy persons should avoid cathartics, the use of improper food, or such as stimulates intestinal peristalsis, while an unhygienic environment (overcrowding, etc.) is to be corrected as far as possible. Shiga recommends that the dead bacillus emulsion (heated at 60° C. for thirty minutes) and a specific immune serum be injected simultaneously. One injection produces active immunity, and the author tested the method on about 10,000 men in the district of Japan “where epidemic dysentery prevails most seriously, and was able to diminish the mortality in the district from 20 to 30 per cent. to about zero.” Morse and Tryon¹ state that prophylactic inoculation will not suppress the disease among feeble patients, although it may have some influence in mitigating its severity. Among strong persons, however, it appears to be of more value in reducing the number of cases and the severity of the disease. Vaccine treatment during the disease has given good results. Nolf² has had splendid results from vaccinothrapy. He uses an autogenous vaccine, if it is possible to isolate a dysentery germ from the intestine. Otherwise a stock culture of *B. dysenteriae* (Flexner strain) is used. He prefers to give the vaccine intravenously at four-day intervals, in doses commencing with 10,000, 30,000, 50,000 and 100,000, and then doubling the dose for each succeeding injection. All sufferers from dysentery must be kept in bed, and should occupy a well-aired apartment.

The **diet** should consist of milk, whey, and light animal broths during the period of active intestinal symptoms. The blandest articles only are either acceptable to the stomach or allowable in the diphtheritic variety, as egg-white and zoölak, in small portions. During convalescence a return to the usual dietary is gradually to be made. All food should be given lukewarm.

¹ *Jour. Amer. Med. Assoc.*, September 15, 1917, p. 940.

² *Ibid.*, 1919, lxxiii, p. 1177.

Stimulants.—With the development of asthenia and cardiac failure stimulants must be employed as in other acute infectious diseases. Diphtheritic dysentery calls from the very outset for free stimulation. The diffusible stimulants (*e. g.*, champagne) are often invaluable. Strychnin and digitalis (hypodermically) may be required.

Medicinal Treatment.—If scybalous masses be passing, a dose of castor oil should be administered. It is well to convert dysentery into diarrhea. Measures to deplete the mucosa of the intestine and at the same time inhibit undue peristalsis are most effective, as magnesium sulphate. Dram doses may be given every hour or two until the stools contain fecal matter and no more blood or mucus. In the later stages purgatives are attended with baneful effect.

Ipecac has long been regarded as possessing a *specific* effect in bacillary dysentery, and in many cases it does reduce the number of bowel movements, relieves pain, and diminishes the amount of pus and blood in the stool; but as ipecac has been shown to have only an amebicidal effect, destroying amebas but having no direct effect upon bacteria, it cannot certainly have a *specific* effect. The drug probably only cured cases of the amebic type improperly diagnosed as of the bacillary type, and hence achieved an undeserved reputation. In spite of this, however, Weil treated numerous cases during the World War with a diet of vegetable soup and subcutaneous injections of emetin hydrochlorid, obtaining the same results as in amebic dysentery. Other remedies should also be employed, and among these opium is particularly beneficial in combination with ipecacuanha or in the form of Dover's powder, which contains both agencies. Three chief symptomatic indications are met by the opium—pain, restlessness, and undue peristalsis—and to obtain the best effects from the opiate it should be administered in the form of morphin hypodermically. In cases in which tenesmus is an unusually distressing feature an opium suppository (gr. ij—0.12) or laudanum (℥xxx—2.0, by enema) exercises a beneficial effect. Bismuth in full doses is useful (3ss to j—2.0–4.0 every two hours), and I have frequently found the combined use of Dover powder, bismuth subnitrate, and salol of signal service. Cunningham, Stengel, and others have reported curative effects from the employment of sulphur; and Richmann prescribes the following powder:

R. Sulphuris sublimat.,	3iv (16.0);
Pulv. ipecac. et opii,	3j (4.0).
M. ft. chart. no. xij.	
Sig. One every fourth hour.	

Antiseptic substances by the mouth for the purpose of disinfecting the intestinal canal and favoring the healing of the ulcerated surfaces after the removal of the necrotic pseudomembrane, such as beta-naphthol (gr. xx—1.3—in the twenty-four hours in divided doses), salol, and silver nitrate, are among the remedies of choice. The naphthol preparations being insoluble should be given in capsule and the silver nitrate in pill form one hour after food. Iodoform in a pill or capsule in doses of $\frac{1}{2}$ to 3 grains (0.032–0.2) has been much lauded. Bose and Vedel employed in 4 cases intravenous injections of sodium chlorid, 7 : 1000 being the maximum strength. The injections should be made early, and repeated, so that they will develop sustained general reaction and a modification of the general condition which can lead to recovery. Care should be taken as to the quantity used and the rapidity with which it is injected ($\frac{1}{2}$ to 3 ounces each minute should not be exceeded). Kendall advises dextrose infusions (25 per cent.) in normal saline solution; this tends to restore the normal dextrose.

Antiseptic irrigation of the bowel would be, if properly carried out, a curative measure, since by this means we may destroy the distinct micro-organisms. Unfortunately, the bowel is frequently so irritable as to seriously interfere with this mode of medication. Preliminary to their use we may also employ cocain in the form of a suppository, or a small quantity of a solution of cocain (4 per cent.), or a laudanum enema (℥xxx—2.0, in starch-water), after which a large injection may be tolerated if administered slowly and the flow be interrupted at intervals. Among the best agents are silver nitrate (gr. ss to j—0.032—0.065—ad ʒj—30.0), tannic acid (1 to 2 per cent.), salicylic acid (1 to 2 per cent.), and mercuric chlorid (1 : 6000). I have for a number of years been in the habit of employing these astringent and antiseptic solutions alternately, administering each once daily. Kuzmitzky, MacDonald, and others have obtained good results with rectal injections of a tepid solution of potassium permanganate (1 : 4000) twice daily. The temperature of the water should, at first, range from 100° to 110° F. (37.7°—43.3° C.), and subsequently this may be reduced. The patient during the administration of the enemata should assume the dorsal position, with the hips well elevated, and he should be turned from side to side during the injections. The existence of great irritability of the bowel may be met by using two catheters side by side, one of them serving as an outflow.

Local means, in the form of hot fomentations, light poultices, and turpentine stupes, often afford much comfort. The various complications must be met by appropriate treatment, as under other circumstances.

Specific Therapy.—Shiga has produced a reliable dysenteric serum which is usually given in 20 c.c. doses. In moderately severe cases the injection may be repeated in six to ten hours, while in very severe cases it may be given twice a day for four or five days. Shiga's serum will cure cases infected with the Shiga bacillus, but has little effect on those cases infected with the Flexner, Duval, or Harris strain of the organism. To obviate the difficulty of requiring agglutination reactions to determine the type of bacilli present in a given case Flexner has attempted, with but fair results, to produce an immune serum which would be effectual in any case no matter with which strain it was infected. The ideal treatment is to inject a serum, if obtainable, derived from the specific causative organism and to give it as early as possible in the course of the disease. Lantin,¹ using the specific treatment in one of three ways, intravenously, intramuscularly, and by rectum, reports most excellent results in a series of 20 cases. The intravenous route for the administration of the serum is probably the best. When given in this manner, 10 c.c. are administered every other day. The agglutination test may be used to determine if the serum will have any specific effect.

Vaccine therapy has been attempted, but the results do not warrant its use.

The results achieved by the use of Shiga's serum in cases infected with this strain of the *Bacillus dysenteriae* have caused a reduction of one-half in the mortality rate as compared to that under medicinal treatment.

CHRONIC DYSENTERY

This form of the disease almost always succeeds an acute attack. A. Bassler thinks that "chronic dysentery due to the *Bacillus coli communis*" seems warranted.

Pathology.—In most instances the large intestine is still the seat of ulceration. Some of the ulcers show no signs of healing; in others this process is going on; while in still others it is completed and puckered cicatrices are

¹ *Philippine Jour. Sci.*, 1918, xiii, 261.

found useful is zinc oxid (gr. v to x—0.3–0.6) three times daily. The latter preparation is decidedly palliative, sometimes even curative.

Intestinal irrigation is to be tried, and various disinfectants and astringent remedies should be alternated as advocated in the acute form. Among individual remedies the silver nitrate (gr. ss to ij—0.03–0.13—ad ʒj—30.0) every second day is doubtless the best. On intervening days antiseptic remedies may be used in solution, such as mercuric chlorid (1 : 6000) or salicylic acid (1 to 2 per cent.); and of other useful agents I may mention tannic acid, alum, acetate of lead, and creolin.

Prior to the use of any of the above-mentioned enemata the bowels should be well flushed with a large injection of tepid water, so as to remove the fecal and other irritating materials. The same details are to be observed in carrying out this mode of treatment as in the acute forms of dysentery. Gallay has related the curative effects of large enemata of a solution of crystallized silver nitrate in distilled water, a scruple to a quart (1.3 per liter), to which 20 or 30 drops of laudanum have been added. Amelioration follows the third or fourth washing, but a course of sixty is recommended to secure permanent relief. The lower part of the rectum should be examined with the speculum, and appropriate topical applications made if ulcers in this situation be discovered. It has been suggested that topical therapy can be facilitated in chronic cases by the production of an artificial anus in the left iliac region or an appendicostomy. This latter operation has been frequently used in recent years in long-standing chronic cases often with brilliant results. The artificial opening should not be closed until the bacilli have been absent from the stools for some months, as there is a tendency for the disease to recur if closure is effected too early.

The *dietetic* treatment in chronic dysentery is of the utmost importance, and light forms of proteins are to be selected, to the exclusion of vegetable substances. Milk is excellent when it can be taken. It is well to examine the stools, and if on microscopic examination curds or numerous fat-globules appear, the amount of milk should be reduced or skimmed milk substituted. Egg-white, meat-broths or beef-juice, whey, and even light, nutritious solids may be allowed. It should be borne in mind, however, that these patients are frequently much run down and anemic. In such case a liberal mixed diet will often aid in effecting a cure after an unsuccessful attempt with a low protein diet. The patient should wear flannels next the skin, and, while open-air exercise is useful, it should be moderate. During inclement weather the patient should remain indoors. I have known change of climate, with proper regulation of the mode of living, to be productive of rather brilliant results. Tonics and alcoholic stimulants are sometimes required to assist the appetite, digestion, and systemic strength, and among the most efficacious tonic remedies are iron, strychnin, mineral acids, and arsenic.

CHOLERA (EPIDEMIC)

(*Asiatic Cholera; Cholera Algida, etc.*)

Definition.—Cholera is an acute, infectious, epidemic disease due to the spirillum of Koch (*Vibrio cholerae Asiaticæ*); and its characteristic symptoms are copious watery dejections, painful cramps, collapse, and suppression of the excretions. In some localities it is endemic.

Historic Note.—During the Middle Ages cholera made deplorable ravages, chiefly along the belts of the Ganges, and has probably been endemic

in India for centuries. Only during the present century, however, has the disease been widely known in Europe and America, and when it has appeared it has always been in the epidemic form. The march of epidemics has been from east to west, along the lines of commerce and travel by land or sea, sometimes spreading over the entire globe. Space forbids an account of the progress of the various cholera outbreaks in Europe and America. It may be stated that there have been no distinct epidemic visitations in America since 1873. In India, Mecca, Java, China, and in the Phillippine Islands numerous cases appeared during the winter, spring, and summer of 1902.

Pathology.—The body is much emaciated, the features sharp and drawn, and the skin of the dependent parts presents a mottled appearance. A postmortem rise of temperature often occurs. The tissues are dry, owing to the draining of the liquids of the body, and hence putrefaction is delayed. Rigor mortis comes on directly after death, is persistent, and the muscles often contract so as to cause the body to assume various uncommon positions.

THE VISCERAL LESIONS.—The chief of these are confined to the intestinal canal. In the early stage the serosa of the small bowel is congested, presenting a roseate hue. The muscularis is relaxed. The mucosa is the seat of catarrh, being deeply injected, swollen, at times edematous, and often coated in the early stage with more or less tough mucus. Shortly the coils of intestine are filled with an almost transparent or slightly turbid liquid ("rice-water"). The solitary follicles and Peyer's patches are swollen, and, in rare instances, become ulcerated. If the patient has died late in the disease (stage of reaction), patches of false membrane may be found anywhere along the intestinal canal, although chiefly in the large bowel; and this secondary croupous-diphtheritic process may attack other mucous surfaces (bile-ducts, vagina).

The *stomach* shows changes similar to those found in the intestines. The *esophagus* also exhibits analogous lesions.

The *spleen* is small, as a rule, though if death occurs late it may show some degree of enlargement with softening.

The *liver* presents marked passive hyperemia and cloudy swelling, with minute spots of beginning fatty change. Desquamation of the epithelium of the cystic mucosa may occur and block the bile-ducts.

The *kidneys* show important lesions, being enlarged from passive congestion, especially the cortex, and the capsule being somewhat adherent. Microscopically, the histologic changes are those of acute nephritis in the cases in which death takes place in the advanced stage. The *bladder changes* differ in no way from those of other mucous membranes. Its mucosa is congested, ecchymotic, and may show diphtheritic deposit.

The Circulatory System.—The pericardium is dry, the parietal layer being covered with an adhesive secretion, while the visceral layer is the seat of ecchymosis. The *heart* is dry and anemic looking. The left ventricle is contracted, while the right is often distended with

Fig. 6.—Comma bacilli (from the mouth);
X 1000 (Günther).

blood and soft clots. Outside of the heart the veins, including the cerebral sinuses, contain most of the blood.

Respiratory Organs.—When death occurs before the stage of reaction the lungs are bloodless, collapsed, and the mouth of the pulmonary artery may be distended. If life is prolonged until the third stage, the lungs may show congestion and edema or pulmonary infarction. The postmortem may now also exhibit the lesions of broncho- or lobar pneumonia.

The brain and its membranes may be the seat of hyperemia except when death takes place at a late period, and then the brain-substance may be more or less bloodless and edematous.

Etiology.—The causes are (a) *specific* and (b) *predisposing*.

(a) The **SPECIFIC CAUSE** is the spirillum of Koch, which is found in the intestinal canal of persons ill of cholera. The form of Koch's organism is that of a slightly curved rod, and its length about half that of the tubercle bacillus, but it is thicker and sometimes has the form of the letter S (Fig. 6). The cholera vibrio is motile, its motility being due to a single flagellum attached to one end. It has been grown successfully on media of various sorts (*e. g.* nutrient gelatin, forming colorless colonies and liquefying the gelatin) and equally successfully inoculated upon inferior animals. Shapsheff¹ found that Esch's agar enables one to detect cholera colonies in cases in which alkaline agar fails.

Outside the body they preserve their vitality in river or well water or upon the surface of moist linen for several weeks. C. Fränkel studied them in flowing water, and in other epidemic outbreaks they have been found in the water used for drinking purposes.

(b) **PREDISPOSING CAUSES.**—(1) **Locality.**—Near to the sea-coast cholera is more common than in the inland districts or towns, and the frequency of occurrence lessens with increasing altitude, this fact possibly being due to a gradual decrease in soil humidity and porosity.

(2) **Temperature and Season.**—The spirillum of cholera can only flourish in a warm climate; hence the disease is *endemic* in certain tropical and sub-tropical climates; and hence also its *epidemic prevalence* is confined to temperate latitudes in the summer and early autumn.

(3) **Debilitating Causes.**—Whenever the private conditions correspond to rigid scientific requirements during epidemic outbreaks cholera becomes less prevalent and also less virulent. On the other hand, defective municipal sanitation, disregard of proper hygienic rules, intemperance, overcrowding, old age, etc., all predispose markedly to the disease.

(4) Mere attacks of **intestinal disorder** due to improper diet, cold, etc., are potent to disseminate the disease.

MODES OF INFECTION.—The spirilla leave the body with the stools, but the most frequent bearer of cholera poison is the drinking-water. As an illustration, Vienna had enjoyed exemption from cholera for nineteen years—a fact attributed to the excellent quality of the drinking-water and to hygienic improvements. On the other hand, in 1872 there occurred in a single commune (Hamburg), which had a polluted water-supply (the Elbe) and no filtration plant, 17,862 cases, with the enormous death-rate of 42.3 per cent. Koch holds that man, not noticeably diseased, is the real bearer and reproducer of the cholera vibrios.

The *choleraic organism* may be conveyed with the water used for washing, cooking, and other purposes. It may be imbibed with such fluids as beer, milk, and tea, and also taken with food-stuffs (lettuce, cresses, and other raw vegetables, fruits, meats, bread, butter). The organisms live on these articles of food from four to seven days at least. The infection may reach the esophagus with the water used for washing the mouth or teeth, or that used for washing

¹ *Russkiy Vrach*, 1916, xv, No. 13.

especially a course of calomel have been used. Lead acetate, opium, and bismuth are used to check the diarrhea.

(b) *Stage of Serous Diarrhea.*—The chief indication is to restore to the blood the watery elements withdrawn by the diarrhea. Not a moment is to be wasted. Opium and, preferably, the salts of morphin may be administered hypodermically (gr. $\frac{1}{4}$ to $\frac{1}{2}$ —0.016–0.02) if the evacuations prove too exhausting. Hypodermoclysis of normal salt solution is indicated, and in large amounts if the preferable intravenous method of Rogers is not used.

L. Rogers reports a decided fall of the mortality from the results of the use of hypertonic salines intravenously combined with large quantities of permanganates by the mouth with a view to destroying the toxins in the bowel by oxidation. Strauss,¹ on the other hand, recommends that when infusion is

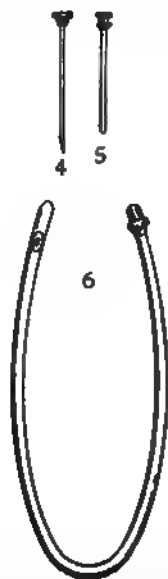


Fig. 7.—1, Fountain syringe; 2, cock; 3, attachment for cannula; 4, needle; 5, cannula; 6, soft-rubber rectal tube, with two lateral openings, one $\frac{1}{4}$ inch from the end (not visible), the other 2 inches from the end. The latter is to be introduced by a combined rotatory and pushing motion to the depth of 10 inches in enterocolitis, and the fluid then allowed to enter the colon slowly.

indicated, an isotonic sugar solution (4.5 per cent. of grape-sugar) should be used instead of the ordinary saline, it being less injurious to the abnormally sensitive epithelium of the kidney.

Rogers' solution contains 120 grains (4.0) of sodium chlorid, 6 grains (0.4) of potassium chlorid, and 4 grains (0.25) of calcium chlorid in 1 pint of water. The initial dose in adults is 3 pints, to be repeated as often as indicated, judging from the amount of fluid lost by the vomiting and purging. In severe cases of collapse Rogers has given 6 pints of the solution as the original dose. The results of this treatment have, on the whole, been most remarkable. Kuhne, following Stumpf's suggestion, has had splendid results in the treatment of cholera by having the patients drink large quantities of a suspension of kaolin. If the patient is too weak to drink, 3 liters of the well-stirred suspension may be given per rectum.

The vomiting is to be relieved by bits of ice, small amounts of brandy and water at brief intervals, cocain, or by lavage. In this stage remedies by the

¹ *Therapie der Gegenwart*, Berlin, October, 1915.

observed, but the internal viscera show no characteristic lesions in cases of average intensity. In severe forms congestion, hemorrhage, degeneration, and necrosis are the changes noted.

After death the *liver* is anemic, as a rule, but in the early stages of the disease it is markedly hyperemic. Its color varies, ranging from pale yellow to an orange hue, and punctiform extravasations cause mottling of the surface. Its size varies little from the normal. Parenchymatous degeneration of the hepatic tissue is common, though in places it may be entirely normal. The liver cells are swollen, containing fat and granular matter, with indistinctness or absence of nuclei.

The *gastro-intestinal mucosa* is the seat of acute catarrh (in severe types) and numerous minute hemorrhages, similar spots of extravasation being found on the various serous membranes of the body (meninges, pericardium, pleura, etc.). Hemorrhagic infarctions may be found in the various internal viscera. The black-vomit material is found in the stomach, and less frequently also in the smaller intestines.

The *spleen* is dark and friable, but is not enlarged. The *kidneys* show the lesions of diffuse nephritis, the microscope revealing cloudy swelling of the epithelium of the tubules, with fatty degeneration and tube-casts. The *heart muscle* looks pale, and may be the seat of granular and fatty degeneration. The *brain* and its *meninges* are hyperemic, and degenerative changes occur in the sympathetic ganglia (Schmidt).

The *blood* is dark, and many of the red corpuscles, having disorganized, set free hemoglobin, as in malaria. Fatty degeneration of the walls of the small blood-vessels and the capillaries have been noted, and these, by allowing filtration of blood-serum, produce concentration of the blood. The serum is of a yellow or orange tint. General glandular enlargement is often found.

Étiology.—Noguchi has shown that yellow fever is probably caused by a minute organism, *Leptospira icteroides*, resembling closely the *Leptospira icterohæmorrhagiæ*. This organism is demonstrable with the dark-field microscope. It is extremely minute and found with difficulty. It can be transmitted to guinea-pigs, in which it reproduces the symptom-complex characteristic of yellow fever. The complete studies by Noguchi of the etiology of yellow fever have been published in the June, July, 1919 and succeeding numbers of the Journal of Experimental Medicine. They are extremely complete and a careful reading will well repay those interested in the subject of yellow fever, as well as those interested in knowing just how the etiology of a disease should be studied to prove that the suspected organism is capable of causing the known disease.

Mode of Transmission.—The work of the Yellow Fever Commission of the United States Army (Drs. Reed, Carroll, Lazear, Agramonte) having thoroughly overthrown the claims of Sanarelli, that the *Bacillus icteroides* is the specific cause of yellow fever, his bacillus is now regarded as a secondary invader. In 1881 C. J. Finley¹ pointed out that the disease is transmitted through the agency of the mosquito. It, however, remained for the commission mentioned above to furnish incontestable experimental proof that yellow fever is a mosquito-borne affection. They have shown that the *Stegomyia fasciata* (*S. calopus*) is probably the only carrier of the infecting agent. Twelve days after biting a yellow-fever subject the bite of the mosquito will infect a non-immune person. The insect is capable of infecting man for a period of several weeks. There is some evidence that the mosquito, once infective, is capable of transmitting the parasite for the balance of its life. The mosquitoes, however, are not infected by biting the dead bodies of yellow-

¹ *Annales de la biol. Academie*, vol. xviii, pp. 147-161.

presents certain symptoms and signs of ill-health during the stage of calm (more or less prostration, epigastric distress with tenderness, mental dulness or even stupor, and a yellowish tint of skin and urine), which lasts from a few to twenty-four hours, when another serious stage supervenes.

Stage of Secondary Fever or Collapse.—The patient becomes extremely weak, presenting the signs of profound *collapse*. The surface of the body is cool (extremities often positively cold), the skin in nearly all instances assuming a yellow or bronzed tinge. It is rarely absent during life, but always present after death. The *pulse* is rapid and compressible, and soon vomiting becomes distressing. *Hemorrhage* into the stomach occurs, the blood being acted upon by the gastric secretions, and producing the material which is expelled as the characteristic *black vomit*. Occasionally unaltered blood may be vomited; the stools also may be tarry. In the worst cases hemorrhages from other mucous surfaces are common (epistaxis, hematuria, metrorrhagia, etc.), and cutaneous hemorrhages also now occur. In this stage the *tongue* becomes dry, brown, or even black; less frequently it is smooth, red, and fissured.

In most cases the *urine* is deficient, containing albumin and casts (with careful centrifugation), and in rare instances there is complete anuria. The latter may precede the development of grave *nervous symptoms*, as convulsions, or even coma, which may be uremic.

In some instances the *temperature* rises during this period (secondary fever), and in favorable cases terminates by lysis, or it may assume the typhoid form and result fatally, and a decided slowing of the pulse may occur, as low as 24 beats even. In all cases that pursue a favorable course convalescence is slow and gradual, and it may be interrupted by certain complications (*e. g.*, abscesses). The *duration* of the entire attack (composed of three stages) is variable, though, as a rule, it covers about one week.

Clinical Varieties.—Many different varieties have been described, each characterized by one or more prominent features, but none seems more justifiable than Finlay's classification, in which he distinguishes three forms: (1) the *acclimation fever*, or *non-albuminuric yellow fever*; (2) the *plain albuminuric yellow fever*; (3) the *melano-albuminuric yellow fever*, characterized by the presence of blood or "black vomit" in the stomach or intestines. Relapses occur, but are rare.

Diagnosis.—Dr. Charles A. Elliott,¹ who acted as the clinician on the Commission for the Study of Yellow Fever appointed by the International Health Board of the Rockefeller Foundation, enumerates the following diagnostic points in order of their importance:

"1. A low continuous fever course with relative bradycardia: A fever of 40° C. or more speaks against yellow fever.

"2. Nause and vomiting: 'Black vomit' is practically diagnostic.

"3. Epigastric pain and tenderness, often intense from the beginning.

"4. Rapid and progressive development of nephritis, with albumin present as a trace on the second day, and increasing to from 1 to 3 gm. per liter on the fourth day.

"5. Flushed face, injected conjunctivæ, swollen and bleeding gums.

"6. The gradual and progressive development of jaundice, apparent in the conjunctivæ as early as the third day."

SERUM DIAGNOSIS.—Woodson and P. E. and J. J. Archinard have applied the Widal reaction (agglutination-test) in 100 cases, and claim that the serum diagnosis of yellow fever is practicable and may be used on the second day. A dilution of 1 : 40 is advised.

¹ *Arch. Int. Med.*, 1920, xxv, 174.

DIFFERENTIAL DIAGNOSIS.—*Pernicious malarial fever* (estivo-autumnal) has not the early, deep jaundice, the slow pulse, the peculiar temperature-curve, the intense capillary congestion of the surface of the body, the black vomit, the early albuminuria, and the clear mind—all symptoms that mark yellow fever. On the other hand, the crescentic or small ring-shaped forms of the plasmodium are pathognomonic of pernicious malarial fever, as is the effect of quinin upon the disease. Kemp has made a microscopic, spectroscopic, and chemical study of the black vomit of yellow and malarial fevers, and found that the pigment was derived from the blood, which had been acted upon by the gastric juices. The vomitus in malarial fever, however, contains, in addition, considerable quantities of bile-pigment and bile-salts, which are wanting in that of yellow fever. Further, in the latter, the vomited matter is much more highly acid. The diagnostic features of *dengue*, which has been confounded with *febris flava*, have been contrasted with those of the latter disease on p. 141.

Prognosis.—Different epidemics show widely different death-rates, and the most potent factor is the particular type of the disease in individual epidemics. Some outbreaks have been characterized by the lighter forms, and in such the death-rate has been low (1 per cent.). In other epidemics the type has been so virulent (with high temperature) as to make the mortality list high—even to 100 per cent. In general, mild epidemics give a mortality of 5 to 10 per cent., and severe ones to 30 to 50 per cent. Bittencourt holds that the greater the displacement toward the left of the Armeth blood-picture, the more unfavorable the prognosis. The death-rate is lower in private than hospital practice.

Among the gravest symptoms are *intense capillary congestion*, coming on during the first stage, *suppression of urine*, *intense jaundice*, and *uremic toxemia*. The black vomit is not as fatal a sign as the symptoms previously mentioned. Tachycardia is always considered grave (Elliott).

It has been noted that a larger number of men, proportionately, than women and children succumb to the disease, and that it is less fatal among negroes than among whites.

Treatment.—The measures that are employed in yellow fever may be considered under three main heads: (1) Prophylaxis; (2) general management; and (3) medicinal measures.

(1) **Prophylaxis.**—Reed claims that the present quarantine laws against yellow fever are needless and the detention system absurd. The effective way to prevent carrying of the fever poison is the destruction of the *Stegomyia fasciata*—on vessels at sea as well as in infected houses and districts on land. Well persons must be protected against the bites of the *stegomyia* by careful screening. It is a twilight mosquito, resting in the middle of the day, hence non-immunes may visit infected localities between 9 A. M. and 3 P. M. with impunity. It is unnecessary to disinfect articles of clothing, bedding, or merchandise supposedly contaminated by contact with those ill of the disease. Gorgas has shown that in Havana, since attention has been directed entirely to the mosquito, the minimum annual death-rate from yellow fever has been reached. The patient must be isolated and carefully screened.

“When a non-immune is going to be exposed to yellow fever it is better to be inoculated, so that he can be put to bed and treated from the beginning, than to take it accidentally” (Gorgas). To immunize a patient a single mosquito should be employed for each inoculation.

(2) **General Management.**—The sufferer from yellow fever must be put to bed at once, and an abundance of fresh air (without exposure to strong

drafts) must be supplied. The medicaments and the nourishment are to be administered through a tube or spout-cup, so as to obviate raising the patient's head. Body- and bed-linen should be kept scrupulously clean, and the patient must not be allowed to leave his bed on any account. The *diet* should be of the lightest sort and entirely liquid, beginning with peptonized milk, koumiss, or light broths.

(3) **Medicinal Measures.**—At the outset it is well to gently stimulate the various excretory organs, and mild laxative diaphoretics and diuretics answer this purpose. Hydrotherapy may be employed to maintain the nervous tonicity and reduce the temperature, but when the spontaneous fall of temperature sets in it must be discontinued. The neuralgic pains, which attack principally the head, loins, and nerve-trunk, are to be relieved by morphin given hypodermically; and for the same symptom Bemiss highly recommends quinin by the rectum (gr. xx—1.3). Intestinal antiseptics may also be used throughout the attack.

During the stage of *remission* the powers of the system are to be fully maintained by a suitable dietary and also by tonics and stimulants if required.

In the last stage supportive measures must not be forgotten. *Rectal nutrient enemata* should be employed if marked gastric irritability prohibits feeding by the mouth. *Stimulants* are demanded, and these should also be administered per rectum if not retained by the stomach, or they may in some measure be administered hypodermically. The stomach is, as a rule, tolerant of iced champagne.

If irritability of the stomach be present, ice and hydrocyanic acid may be tried. Sodium bicarbonate (gr. x to xx—0.6–1.3) in Vichy, Apollinaris, or Seltzer water is a most useful remedy.

Perhaps the chief indication for the use of sodium bicarbonate is the extreme acidity of the various secretions, especially the gastric and renal. Sternberg contends that by fulfilling this indication we prevent in great measure the occurrence of acute nephritis and suppression of the urine. Hemorrhages and other symptoms must be treated by the usual means. During convalescence tonics are to be administered, and the customary diet can gradually be resumed.

Specific Therapy.—As the causative organism has not been discovered it is impossible to develop any type of specific serum or vaccine therapy. Sanarelli recorded favorable results from the use of his antitoxic serum, but as the organism he thought to be the cause of yellow fever has been shown by the Reed Board to be a variety of the hog-cholera bacillus, Sanarelli's results can be completely discounted.

CEREBROSPINAL MENINGITIS

(*Spotted Fever; Cerebrospinal Fever*)

Definition.—An infectious disease caused by the *Diplococcus intracellularis meningitidis* (Weichselbaum). It is characterized anatomically by inflammation of the meninges of the brain and spinal cord, and clinically by an irregular course, a moderate febrile movement with somewhat characteristic and profound nervous symptoms (excruciating headache, pain in the back and upper part of the spine, contraction of the muscles of the nucha, hyperesthesia, delirium, and oftentimes coma). The disease may occur sporadically or in epidemics, or may even assume pandemic proportions.

Historic Note.—Cerebrospinal meningitis was first recognized and described as late as the beginning of the last century (1805) by Viessieux, of Geneva. During the next decade numerous limited epidemics were observed both in Europe and the United States, and subsequently recurring epidemic and pandemic visitations were noted, though at longer and variable intervals of time. In nearly all the large cities in this country it has become endemic, and in Philadelphia since 1863.

Pathology.—The cases that prove speedily fatal do not present gross characteristic changes, but by the aid of the microscope leukocytes are discovered immediately around the cerebral vessels, and round cells in the cortex of the brain. In some cases the characteristic evidences of encephalitis are already noticeable. On the other hand, the cases in which death occurs after the disease has been fully developed show the lesions of suppurative inflammation of the meninges of the brain. The arteries, veins, and sinuses are much engorged; the ventricles are distended with liquid, but the pia mater is principally affected, its vessels being greatly enlarged, and a more or less copious serofibrinous or seropurulent exudate occurring into the meshes of its network. The longer the duration of the case, the more purulent is the exudation. The ventricles of the brain are filled with a similar exudation, and red blood-globules may be present at an advanced stage. The color of the exudate is at first almost clear (being composed of serum); it then changes to a milky turbidity, to a pale yellow, and lastly takes on a greenish-yellow color ("leek-green"). The subarachnoid space may be occupied by a uniform layer composed of fibrin and pus.

The brain-matter is congested, and sometimes softened in spots, and on section the gray matter may present punctate extravasations. When resolution occurs recovery may be complete, but frequently the pia mater remains thickened. The exudation may follow the auditory and optic nerves along their lymph-sheaths, and pus has been found in the internal ear as well as in the chambers of the eye.

The membranes of the spinal cord manifest lesions identical with those of the brain. They are vascular engorgements, followed by serofibrinous, and later still by seropurulent, exudation beneath the arachnoid. The changes are more marked on the posterior than the anterior surface of the cord, and the exudate increases in amount in passing from above downward, in severe cases sometimes assuming the form of a sheath which completely surrounds the cord throughout its entire length. The pia mater is congested, and may be thickened, shaggy, and in places adherent to the cord, of which the gray matter may be the seat of serous infiltration, and rarely of softening. Barker describes certain changes that occur in the nerve-cells and the ventral horns of the nucleus dorsalis (Clarkii) of the spinal cord in epidemic cerebrospinal meningitis.

The lungs may exhibit the changes peculiar to bronchitis or pneumonia. In the heart endocarditis may be noted, though rarely, and both the pleura and the pericardium may show inflammatory lesions and contain a serous or seropurulent exudation. Hemorrhages into the serous membranes and into the skin may take place. The spleen may be enlarged, the increase in size and the degree of fever being proportional, and the liver is hyperemic. The kidneys are congested, and bacterial forms have been found associated in the latter with the lesions of acute nephritis and hemorrhage—conditions of which they were probably the cause.

Etiology.—**BACTERIOLOGY.**—The meningococcus is the specific cause of epidemic cerebrospinal meningitis. Dopter has classified this organism into two groups, namely, meningococcic and parameningococcic. Ellis has also described two groups, Types I and II, the organism described as Type II being

probably identical with the parameningococcus of Dopter. The two types of meningococci causing the disease, however, are absolutely independent as regards the agglutination reaction. Arkwright points out that rapidly fatal cases of meningitis occur with infection with either type of meningococci. More recently the Rockefeller Institute workers have classified the specific organism into three types, while the English Army recognizes four types. The special organism can be isolated from the spinal fluid, the meninges of the brain and cord, the blood, the joint lesions, and the nasal mucus.

The meningococcus, like the gonococcus, occupies a position within the polynuclear leukocytes, but never appears within the nucleus (Park), and the latter is biscuit shaped. The bacterium takes the usual stains. It develops upon agar-agar and upon Löffler's blood-serum, manifesting characteristics of growth that simulate those of the pneumococcus. Councilman, Carl Fränkel, Boston, and others, by refined methods, have, however, been able to differentiate these organisms. Among the associated microbes are the pneumococcus, *Streptococcus pyogenes*, *Staphylococcus aureus*, *Bacillus coli communis*, and the tubercle bacillus, and any one of the latter is capable of causing sporadic cerebrospinal meningitis.

PREDISPOSING CAUSES.—(1) **Age.**—Most cases occur in children and young adults, though no age enjoys perfect immunity. Of 94 cases occurring in children up to fifteen years of age, 56 were under five years (Claytor).

(2) **Climate.**—The disease is unknown in tropical climates, but has occurred in all parts of the temperate zone, and is most prevalent in the more northerly portions of the latter.

(3) **Season** is not an important factor, though the disease prevails largely in winter and spring. April and May have been called the "meningitis months."

(4) **Unhygienic Influences.**—The disease often appears in ill-ventilated and overcrowded habitations—among the poorer classes, among soldiers crowded together in barracks, and among prisoners. In the French Army the incidence of meningitis was as follows: 1915, 0.42 per 1000; 1916, 0.18; and 1917, 0.15.¹ Prolonged marching and excessive physical or mental exertion may heighten susceptibility. In certain epidemics the disease has raged exclusively in villages.

MODES OF CONVEYANCE.—The germ may linger in the accessory nasal sinuses after clinical recovery, while during an epidemic the germ has been found in the nasal passages of large numbers of healthy individuals. However, though many persons are carriers of the meningococcus, it is only an occasional carrier who can liberate germs which are pathogenic to others. The organism is transmitted from the carrier to a susceptible individual by sneezing or coughing. As to the manner in which the germ gains entrance to the system, it has been quite definitely proved that the meningococci first inhabit the nasal passages and is then transferred to the meninges by way of the blood, producing a primary blood infection with a secondary meningitis.

Clinical History.—The period of incubation is brief, though unknown. The prodromal symptoms are variable in different epidemics. Invasion may be sudden, a patient in vigorous health often being stricken down as though by a blow. In some rapidly fatal cases there is a short prodromal period during which the patient complains of lassitude, headache, rachialgia, muscle- and joint-pains, and sometimes nausea and vomiting. In ordinary forms the prodromes may last from a few hours to a week or more, and the patient's complaint may be limited to cervical and occipital pains lasting a day or two; then, without any initial chill, the invasion period supervenes. Herrick and his

¹ *Bull. de l'acad. d. méd.*, 1918, lxxix, 169.

may deepen quickly into coma, perhaps temporary, though more often it continues until recovery or death. Vomiting is common, usually late in the disease; it is doubtless of cerebral origin.

Symptoms of motor irritation are common, twitching of single muscles or groups often being seen, and occasionally muscular tremors. Muscular contraction is an almost constant feature. After a few days a tonic spasm of the muscles of the extremities sets in, bending the arms upon the chest, the forearm upon the arm, and the thumb upon the palm; the thigh is also flexed on the abdomen and the leg on the thigh. The opisthotonos may be followed by trismus, which can be considered a mortal symptom. Convulsions do not occur in adults, but are common in children; occasionally there is paralysis (facial hemiplegia).

Organs of Special Sense.—*Photophobia* is a prominent symptom, and the condition of the *pupils* is very variable. They may be dilated or contracted (more frequently the former) or remain normal; and in the majority of cases they are unequal in size and react poorly to light.

Strabismus is frequent, usually temporary, though it may recur during the attack. Rarely it is permanent. *Conjunctivitis* of moderate intensity and *keratitis* may occur, the former being common. Burville-Holmes¹ invites attention to anesthesia of the cornea and conjunctiva, which occurs in about one-half of the cases. *Ptosis* is almost always present. Intense purulent *iridochoroiditis* sometimes occurs; either temporary or permanent *blindness* and, rarely, *nystagmus* are noted. Among optical sequelæ are cataract and atrophy of the eyeball.

Deafness is common, there being an early intolerance of sound and a marked tinnitus aurium. Late suppurative inflammation of the middle ear, followed by rupture of the tympanum and *otorrhea*, may occur. The internal ear may be similarly involved, with uncertain *gait*.

Cutaneous symptoms appear, some of which possess considerable diagnostic worth. *Pallor* and *lividity* of the skin and visible mucous membranes often characterize the period of invasion, and shortly after the onset *herpes facialis* appears in more than half the cases. This symptom is significant for diagnosis. The separate lesions are extensive, and often coalescence of two or more is witnessed. Herpes facialis belongs in a peculiar sense to cerebrospinal meningitis; herpes labialis to malaria, and less frequently to pneumonia and meningitis. A *petechial eruption* is common in the early epidemics, and more frequently in America than in Europe. To this symptom the disease owes the name, long since given to it, of "spotted fever." It may, however, be absent, and when present it is sometimes limited to a small superficial area, though more frequently it is diffuse. Of the 191 cases of meningococcic meningitis seen by Stone¹ at Fort Riley in 1917–18 petechiæ were present in 6 per cent. of the recovered and 14 per cent. of the fatal cases. At first the eruption may be bright red (erythematous), later becoming darker, or it may be distinctly petechial from the start; purpuric spots of considerable size and sometimes large ecchymoses may appear, but these are most common in the more malignant types. Other forms of eruption are also seen (sudamina, urticaria, ecthyma, erythema, erysipelas, etc.), but are devoid of diagnostic value. *Gangrene* of the skin is occasionally noticed, and in some cases bed-sores are liable to arise; but there is no fixed time for the skin lesions of cerebrospinal fever to appear, and their duration is exceedingly variable.

Of **gastro-intestinal symptoms**, *vomiting* is the most common. It usually lasts only for a brief period at the onset, though it may recur later at longer or shorter intervals, and is of nervous origin. The *appetite* may be good, but

¹ Arch. Int. Med., 1919, xxiii, 282.

pericarditis) are among associated conditions, and secondary bronchitis is common. *Pneumonia* (lobar and lobular) is a frequent complication. Endocardial murmurs are common, but pericardial friction is less so. *Hemorrhagic nephritis* is a rare complication. Latham¹ reports 24 cases of epididymitis as a complication.

Special and Atypical Forms.—(1) **Mild or Rudimentary.**—In this type the characteristic signs are either undeveloped or wanting, and the diagnosis is possible only during the prevalence of epidemics, which furnish typical cases. The most constant and significant symptoms are severe headache, languor, vertigo, nausea, and occasionally vomiting. Fever and contraction of cervical muscles are absent, as a rule. The duration is brief, rarely exceeding three or four days.

(2) **The Abortive Form.**—Here the initial symptoms are severe, but after two or three days they rapidly subside, leaving the patient convalescent. The disease is cut short by the acquisition of immunity, and not as the result of medical interference.

(3) **Intermittent Form.**—In this variety the symptoms, however intense, remit or almost wholly intermit every day or second day; these remissions are followed by a decided exacerbation or recurrence of the distressing features of the disease. Intermissions often occur at an advanced stage. There is not observed the strict periodicity that is seen in malaria. Neither is the malarial plasmodium found in the blood.

(4) **Typhoid Form.**—In certain cases the special features are characteristic of the "typhoid state," with protracted course.

(5) **Fulminant or Apoplectic Form.**—The symptoms characterizing this most malignant type of the affection are rather inconstant. There may be severe chill, loss of consciousness, followed by deep coma and death, the whole course occupying the space of a few hours only. I saw two such cases in the same family: the first, a girl of five years, was stricken at 2 P. M. and died at 9 P. M.; the other, a boy of seven years, was taken ill on the following day about the same hour, and died at 10 P. M. Other instances pursue a somewhat slower course, though manifesting the most striking malignancy. These begin with intense chills, violent headache, vomiting, early stupor, great prostration, contraction of muscles of the neck, moderate fever, and a feeble, progressively slowing pulse until it sometimes reaches 50 or even 40 beats per minute. The eruption, when it appears, takes the form of purpura. This form is most apt to be met with early in an epidemic, and with few exceptions proves fatal.

(6) Schlesinger states that epidemic cerebrospinal meningitis affects a senile type in elderly subjects, with little tendency to fever or opisthotonos.

Diagnosis.—In the premeningitic stage the most characteristic symptoms are an upper respiratory tract infection; fever rarely above 101° F.; an apathetic, but irritable when disturbed, mental state; a petechial rash, appearing in crops; and unequal increase of the deep reflexes. In the fulminating or well-developed cases the most important symptoms for diagnosis are the abrupt onset; intense pains (cervico-occipital and lumbar); prostration; vomiting; vertigo; somnolence, alternating with local or general tonic or clonic convulsions; delirium (often sportive in type); tonic contraction of the muscles of the neck, extending to the back; marked hyperesthesia; a slow, followed by a more rapid, though variable, pulse; irregular temperature-curve; and certain eruptions (petechial, herpetic).

In the premeningitic stage it may be possible to isolate the organism by blood culture before it can be demonstrated in the spinal fluid, and cases

¹ *Jour. Amer. Med. Assoc.*, January 18, 1919, p. 175.

puncture is the chief diagnostic aid in diagnosis of the type of meningitis present.

(2) *Pneumonia*.—This affection may be complicated with a meningitis that affects chiefly the cerebral cortex. Hence, while there will be motor spasm (more or less localized) and tremors, there will also be less retraction of the head and less myalgic pain than in cerebrospinal meningitis. Again, pneumonia precedes the development of the meningeal symptoms.

(3) *Typhoid Fever*.—The cerebral type of this affection may simulate closely meningitis. In both may be observed fever, delirium, somnolence, retraction of the neck, spasm, tremor, and profound prostration. The mode of onset, however, is different, being slower in typhoid and unaccompanied by vomiting, muscular spasm, or hyperesthesia. In typhoid there is also the characteristic mental dulness; the fever is higher, with a typical fever-curve; the roseate eruption and seroreaction are characteristic, and there is greater enlargement of the spleen.

Sequelæ.—The leading sequelæ are permanent blindness (due to optic neuritis with atrophy) and deafness, which sometimes terminates in deaf-mutism; and in many cases headache outlasts the disease for months. Chronic hydrocephalus and mental enfeeblement are not rare sequels (Ziemssen). Various local paralyses are observed, probably due to certain peripheral lesions (neuritis and perineuritis). Rosanoff¹ has had an opportunity of studying the "residuals" of epidemic cerebromeningitis in 26 patients who had had the disease seven to nine months before coming under his care. He noted "a fairly uniform syndrome made up of the following elements given here in order of their frequency: 1, Limitation of flexion of the spinal column; 2, undue fatigability; 3, pains in back, legs, and head; 4, tendency toward dizziness and faintness; 5, muscular weakness; 6, tendency toward blurring of vision associated with photophobia; 7, impairment of appetite and sleep associated with a state of undernutrition."

Immunity.—Permanent immunity is rarely conferred by the occurrence of cerebrospinal meningitis, *relapses* being common, and *second* (recurrent) attacks having been occasionally observed.

Duration and Prognosis.—In very mild forms the duration is from one to four or five days. The most malignant type runs an even shorter course, when, as is the rule, it terminates fatally. If recovery ensues, it is after a long, serious, and protean illness. The *abortive form* is necessarily of brief duration. In the ordinary type convalescence usually sets in at the end of one or two weeks, but a slow convalescence, hindered by numerous complications and sequelæ, is the rule.

Apart from the *fulminant form*, which nearly always proves fatal, the severity of the infection may be appreciated by noting the degree of fever and the intensity of the nervous symptoms, especially the vomiting, coma, headache, opisthotonos, character of the respirations, etc. *Complications* may likewise affect the prognosis, pneumonia and suppurative inflammations of the pleura or pericardium rendering it particularly grave. In *children* under two years the disease is very fatal, this period giving the highest mortality rate; between two and five and after thirty years it is a more serious disease than during young adult life. The death-rate of cerebrospinal fever varies greatly in different epidemics, ranging from 25 per cent. in the mildest to 80 per cent. in the severest.

Prophylaxis.—Disinfection of the nasopharynx is recommended with a view to destroying the specific organism. Meningococcus carriers must be discovered and treated by swabbing out the upper air-passages with a weak

¹ *Jour. Amer. Med. Assoc.*, 1918, lxxi, 1476.

solution of argyrol, dichloramin-T, or some other antiseptic. Isolation is to be carried out of all those exposed and their nasopharynges sprayed with antiseptic or cleansing solutions. Cultures should be taken of the nasopharynges of those exposed and quarantine should be continued until three consecutive cultures taken three days apart have been reported by the laboratory as negative. Sophian and Black claim that the injection of dead meningococci confers considerable immunity.

General Management.—The sick-room must be quiet and somewhat dark. All excitement is to be avoided; the patient must not be allowed to leave his bed until convalescence is firmly established.

The *diet* should be composed of nutritious liquids, such as milk and animal broths, etc., and as soon as convalescence begins the dietary should be increased by the addition of semisolid substances (rice, eggs, milk-toast, etc.), and, finally, the more easily digestible solids. The period of convalescence may be much abridged by systematic feeding.

Medicinal Treatment.—Individual cases are to be treated according to the special indications presented. I regard it as improbable that any case of this affection has been benefited by venesection.

Among medicinal agents narcotics are the most useful. Morphin hypodermically affords relief from intense headache, myalgic pains, muscular contraction, and other nervous symptoms in some cases. If the respirations be irregular, atropin may be combined with the opiate; and if the heart threatens to fail, strychnin may be administered. Should morphin fail, the bromids and chloral (the latter in small doses) are to be employed. In young children we must rely upon the bromids.

For the tonic contraction of the muscles and violent cerebral symptoms *cannabis indica* should be tried. Convulsions call for hot baths (105° F.—40.5° C.) or ether inhalations. Belladonna and ergot have been employed in the early stages to diminish the congestion of the cerebrospinal capillaries.

Stimulants are required if signs of heart-exhaustion appear. They may be freely exhibited in accordance with the customary rules.

After effusion of the exudate has taken place, the narcotics are to be replaced by agents that promote absorption, as potassium iodid.

Specific Therapy.—Flexner and Jobling present a report on 393 patients treated with Flexner's curative serum. Of these, 295, or 75 per cent., recovered and 98, or 25 per cent., died. Paleani¹ emphasizes the importance of making the serum from the strains of meningococci found in the cases during the epidemic. When the cerebrospinal fluid was found sterile he took cultures from the nasopharynx to make the antiserum. The serum is injected into the subarachnoid space by means of lumbar puncture. It is permitted to run in very slowly by gravity after 20 to 40 c.c. of fluid have been withdrawn. About 5 c.c. less of the warmed serum are given than the fluid withdrawn. If, however, the amount of fluid is small and the serum runs in readily, 5 to 10 c.c. more may be given than fluid removed. Moreover, if a case is doing badly, large amounts, up to 40 c.c., may be given if it runs in readily and if the patient is not made very uncomfortable and no change in the respiratory and pulse-rate occurs. The serum must come into direct contact with the specific organism, therefore it is of no avail if given intramuscularly. Only when injected into the spinal canal does it exert its specific effect. The serum is harmless, and in doubtful cases or in case the spinal fluid shows any turbidity should be injected immediately without waiting for laboratory examinations. The serum should be injected daily or in grave cases every twelve hours until im-

¹ *Jour. Amer. Med. Assoc.*, November 24, 1917, p. 1834.

provement is shown. In any case it is advisable to give daily injections until the fluid is sterile. Failing bacteriologic examination, the treatment should be continued until the fluid is nearly clear, the temperature normal, and the symptoms greatly relieved. It is necessary at times to give as many as fifteen or twenty injections. Herrick¹ has proposed a method of treating meningitis from which he has had excellent results and which seems to be a decided advance in the treatment of the disease. As there is definite proof that there exists an early stage of meningitis in which the meningococci are circulating in the blood and in which spinal fluid is still clear, he advises the intravenous injection of the serum in conjunction with intraspinal therapy. The method of treatment that he recommends may be summarized as follows: A patient with early suggestive symptoms is subjected to lumbar puncture. If the fluid is cloudy a small amount is withdrawn to reduce the intraspinal pressure to approximately normal and a less amount of serum injected. If the fluid is clear, no serum is injected. Meanwhile the patient receives a desensitizing dose. One hour later 50 to 120 c.c. are injected in the vein, the first 15 c.c. being injected in fifteen minutes; a large glass syringe is used to hold the serum. In cases of moderate severity the intravenous dose is every twelve hours until the temperature is normal, six to eight doses as a rule. In severe cases the dose is repeated every eight hours. The size and frequency of the dose is comparable to that used in the treatment of pneumonia. When meningitis develops the usual intraspinal injections are given every twenty-four hours until the meningococci disappear from the spinal fluid and lymphocytes appear in large numbers. In a more recent contribution, Stone and Truitt² recommend the following routine: First day, 60 to 80 c.c. serum and two intraspinal injections of from 60 to 80 c.c. each after spinal drainage of from 45 to 55 c.c. of fluid, depending on its pressure; second day, same, except that from 80 to 100 c.c. of serum should be given intravenously, and two spinal injections; third and fourth day repeat, if necessary; fifth to eighth day, one spinal injection; ninth and tenth days, one daily spinal drainage. The importance of this procedure suggested by Herrick cannot be too strongly emphasized. The results with it have been splendid; for example, Haden³ at Camp Lee had a mortality of only 6.6 per cent. of his cases treated this way, compared with a mortality of 37.5 per cent. treated by the intraspinal method. Landry and Hamley⁴ likewise has splendid results with the cases they treated by this method. Of course an early diagnosis is of importance with cases for this method of treatment.

THE PNEUMOCOCCIC INFECTIONS

There are many diseases caused by the pneumococcus, among them the pneumonias (lobar and lobular), pleuritis, pericarditis, meningitis, pyelitis, and arthritis. These, with the exception of lobar and bronchopneumonia, will receive due consideration in appropriate sections elsewhere throughout this volume, since the pneumococcus forms only a part of their bacteriology. Again, the conditions mentioned above occur as complications of the type of the pneumococcus infections, or lobar pneumonia, hence will be also discussed under the presentation of that disease, which is the most important acute infection. In this connection mention should be made of certain common conditions which have recently been shown to be caused at times by the pneumococcus, such as suppurative inflammation in the sinuses, tonsils, ears, and mouth (gingivitis).

¹ *Arch. Int. Med.*, 1918, xxi, 541.

² *Ibid.*, 1919, xxiii, 282.

³ *Ibid.*, 1919, xxiv, 514.

⁴ *Amer. Jour. Med. Sci.*, 1919, clvii, 216.

LOBAR PNEUMONIA

(Croupous or Fibrinous Pneumonia; Pneumonitis; Lung Fever)

Definition.—An acute infectious disease caused by the *Micrococcus lanceolatus*, which produces a specific inflammation of the parenchyma of the lung and marked constitutional disturbances—chill, extreme prostration, and fever which terminates by crisis. There are different forms of lobar pneumonia, as primary lobar pneumonia, secondary lobar pneumonia, and pneumonia with the formation of new connective tissue.

Pathology.—Usually the lesions are confined to the whole of one lobe; less frequently to the whole of one lung, and rarely to parts of both lungs. From Jürgensen's analysis of 6666 cases the following statement, showing the different situations of the lesions and their relative frequency, was taken: Right lung, about 54 per cent.; left lung, about 38 per cent.; and both lungs, about 8 per cent. In the right lung the lower lobe was involved in 22 per cent., the upper in 12 per cent., the middle in nearly 2 per cent., and the whole lung in about 9 per cent. In the left lung the lower lobe was involved in about 23 per cent., the upper in about 7 per cent., and the whole lung in about 8 per cent. The disease involves whole segments of the lungs, and these may embrace more than one lobe.

The lesions of pneumonia are divisible into three stages: (a) Stage of congestion or engorgement; (b) red hepatization (consolidation); and (c) gray hepatization.

(a) **STAGE OF ENGORGEMENT.**—The part or parts implicated are of a dark-red color and firmer to the feel, but less resilient and crepitant than normal. The cut section drips a blood-stained serum and dark blood exudes from the distended capillaries. The air-cells do not collapse, though they are not solid, since excised pieces float; but the weight of the lung-tissue is much increased. Collapsed portions may be observed which may readily be insufflated from the bronchus, and areas of extravasation may occasionally be noted near the pulmonary pleura.

On *microscopic examination* the alveolar epithelium is seen to be swollen, the capillaries greatly distended, and the air-cells containing alveolar epithelial cells, red corpuscles, and a few leukocytes. Similar elements occupy the small bronchi.

(b) **RED HEPATIZATION.**—The affected tissue is solid, airless, and firm, resembling, as the term indicates, liver-tissue. It is reddish-brown (mahogany) in color, presenting a dry, mottled appearance, and when, as is usual, an entire lobe is involved, it is more voluminous than normal and its surface is often furrowed by the impress of the ribs. Being airless, the affected portion does not crepitate, and its weight and specific gravity are increased. It cannot be inflated, is extremely friable, and its lacerated surface presents a finely granular aspect, this latter appearance being due to the minute plugs of inflammatory matter (fibrin) which fill the air-spaces. The air-passages and small bronchi are distended with similar material, and granular masses can be removed from the air-cells of a cut or lacerated surface by carefully scraping the latter. If death takes place during this stage, the antemortem, dry, inflammatory exudate soon softens, and may flow from the cut section as a grumous, viscid fluid; the consolidated tissue sinks rapidly in water. The pulmonary pleura is covered with a fine sheet of fibrin, and in cases complicated by marked pleurisy the fibrinous, inflammatory exudate forms a thick coating upon the pleural membrane, and the sac may contain liquid effusion.

(c) **GRAY HEPATIZATION.**—In this stage the fibrinous exudation becomes decolorized, the surface at first resembling granite in color, and later appearing uniformly gray. Associated with this change and following it there is fatty granular degeneration of the inflammatory exudate, in consequence of which the latter becomes moist and soft. The exudate loses its granular character, while at the same time the friability of the lung-tissue is further increased, and from the surface of the cut section there flows usually a grayish-white or yellowish-white purulent liquid. Not less than one-half of the fatal cases die in the early part of this stage. The pleura is usually covered with a fine fibrinous exudation.

Resolution usually corresponds in time with the occurrence of the crisis, though it may begin later. Pratt found larger phagocytic cells in all stages of the disease; it is likely that they play an important part in resolution. More recently Lord¹ has advanced the hypothesis that resolution is the result of local biochemical changes in the affected lung bringing about increased hydrogen ion concentration of the exudate, causing in turn the death of the pneumococcus (causing the crisis), and followed by the liberation of an enzyme which is capable of splitting peptone to amino-acid nitrogen when activated by the increased acidity. Among unfavorable terminations are:

(1) **Purulent Infiltration.**—Here the lung-tissue becomes very soft, friable, and is bathed in purulent material; and microscopic observation shows the pus-cells densely infiltrating the interalveolar tissue and filling the air-spaces as well. Necrosis of the lung texture may occur, producing abscess.

(2) **Abscess.**—This is due to subsequent infection by pyogenic cocci, hence is a complicating lesion. The abscesses vary in size within wide limits, most frequently being situated near the base of the lung. In most instances the abscess cavity has a fistulous connection with a bronchus, but occasionally the abscesses become encapsulated in fibrous tissue, their contents undergoing first caseous and then calcareous degeneration. When multiple, they sometimes coalesce, forming large abscesses.

(3) **Gangrene** may rarely follow, but is due to a specific cause.

(4) **Induration.**—A. Fränkel states that in a few instances (about 1 per cent.) pneumonia ends in induration, and is found upon section to be smooth and its tissue resistant (*vide* Chronic Interstitial Pneumonia).

(5) Pneumonia, particularly of the apex, may terminate in phthisis. Tubercular infection commonly occurs in unresolved pneumonias.

Changes in Other Viscera.—The *heart* often appears pale and is flabby, but upon microscopic examination the muscular cell-fibers of the organ are not found to be degenerated except in rare, protracted cases. The cardiac chambers, particularly the right, are distended with firm, tough clots, which are usually removable *en masse* from the great vessels in the form of arboreal casts. The blood tends to coagulate promptly owing to the fact that its fibrinous elements are vastly increased, although Dochez found the coagulation time to be generally prolonged. Flexner found that coagulation was favored by auto-agglutination of the red cells. The studies of Anders and Meeker² indicate that the coagulation time is somewhat shortened, but that the causes of this abbreviation are not definitely known.

Pericarditis occurs in about 5 per cent. of the cases, and is relatively more frequent in right-sided or double pneumonia. *Endocarditis* is more common, especially the ulcerative form—in 11 out of 100 autopsies (Osler). With malignant endocarditis the lesions of meningitis are often combined, but as a separate complication the latter is rare.

The *spleen* is congested, moderately enlarged and softened, and the *liver*

¹ *Jour. Exp. Med.*, 1919, xxx, 379.

² *Jour. Amer. Med. Assoc.*, November 26, 1916, p. 1591.

is likewise hyperemic and somewhat swollen. In the *kidneys* are found the lesions of parenchymatous inflammation, and with remarkable frequency also those of chronic interstitial inflammation. A catarrhal state of the gastrointestinal mucosa (often with jaundice) is common; and a frequent complicating change is croupous inflammation of the colon.

When the infection is caused by the Friedländer bacillus the diseased portions of the lung are increased in volume, and multiple foci may be formed throughout one lobe (Kokawa). The cut section is characterized by a slippery sensation to touch owing to the presence of a large amount of mucus, especially in the early stages. Swelling, proliferation, desquamation, and necrosis of the epithelium are observed. The fibrinohemorrhagic exudate is not great, the large emigrated leukocytes and the epithelial cells forming the principal constituents of the exudate in the later stages. The bacilli are taken up by the epithelial cells and leukocytes, which swell up and develop vacuoles. Other infections may be caused by the pneumobacillus—pleuritis, endocarditis, pericarditis, abscesses, otitis media, and osteomyelitis.

Etiology.—**BACTERIOLOGY.**—The generally accepted specific cause of pneumonia is the *Diplococcus pneumoniae*. It is a lance-shaped (slightly elliptic) coccus, united in pairs; when typical has the shape of two cartridges placed end to end, is surrounded by a pale capsule, and is present occasionally in the nose, eustachian tubes, and larynx of healthy individuals. Netter found it in 20 per cent. of the specimens of buccal secretion taken from well persons, and "it is the migration of these ever-present germs into the pulmonary alveoli which causes pneumonia" (Wells). Dochez and Avery have shown that pneumococci fall into four definite pathologic groups, which they have arbitrarily numbered from I to IV, the first three groups being closely related to each other. These vary in pathogenicity for human beings, the order of virulence being as follows: Groups III, II, I, IV. A study of the sputum from normal individuals revealed organisms which belong to Group IV, a heterogeneous group, which are not closely allied the one to the other. These are of low virulence, and it may be assumed that the majority of cases of pneumonia are due to organisms not found in normal mouths. Clough¹ determined the group in 121 strains of pneumococci, the percentage incidence being as follows: I (35.2), III (14.8), IV (25.9), and II (22.2, typical and atypical). The pneumococcus is present in about 90 per cent. of all instances of pneumonia, and in persons who have had the disease it is detectable for many months or even years. It is generally present in pure culture, but may be associated with pyogenic organisms. It is probable that Friedländer's bacillus (discovered in 1883) and other microorganisms (Eberth's bacillus, bacillus of Pfeiffer, streptococcus of erysipelas, *Bacillus pestis*) may also have the power to cause the disease; and Wassermann suggests that specific forms of pneumonia may coexist in the same individual, as, for example, lobar pneumonia and influenzal pneumonia. The organism grows upon all the culture-media except potato between the temperatures of 24° and 42° C. (McFarland). The *Diplococcus pneumoniae* (Fig. 8) can be readily demonstrated in the sputum by treating a fixed cover-slip preparation with glacial acetic acid which is allowed to drain off and is replaced (without washing in water) by anilin oil gentian violet solution; this is to be poured off and renewed two or three times.

The Pneumococcus in Other Diseases.—It has been found in pure culture in pleuritis (including empyema), pericarditis, meningitis, peritonitis, endocarditis, synovitis, bronchopneumonia (principally in adults), acute abscess, and other conditions.

The **mode of infection** is by inhalation, although there may be other portals

¹ *Bull. Johns Hopkins Hosp.*, October, 1917, p. 306.

occurred in the spring, 32 per cent. in winter, 15.7 per cent. in autumn, and 15.3 per cent. in the summer. In London most cases appear between the end of March and the end of June (Herringhan). My own analysis of the monthly mortality list covering the decade from 1894 to 1903 inclusive, for Philadelphia, gave the following numerical order: January, 4210; February, 3717; March, 3496; April, 3039; December, 2860; May, 2238; November, 1936; October, 1296; June, 1165; July, 913; September, 826; August, 800. Exposure to cold is incapable, *per se*, of giving rise to pneumonia. Longcope and Fox have shown that the saliva of healthy persons containing the pneumococcus increases in virulence during the winter months. Greenberg¹ thinks that the temperature is the most important contributing factor.

(5) **"Catching cold"** is often followed by pneumonia, but frequently there is no such history. The so-called "cold" is a predisposing cause, rendering the respiratory passages more than ordinarily susceptible to pneumonic infection. Such facts as these also explain why pneumonia occurs with undue frequency in persons following certain occupations.

(6) **Traumatism.**—Following injuries and contusions, especially of the chest, which lower the vital power and resistance of the tissues.

(7) **Age.**—Lobar pneumonia is common at all periods of life, but before two years of age it is comparatively infrequent. Between the ages of twenty and forty susceptibility is increased, and again after the sixtieth year of life it augments rapidly. McDonald² reports a case of antenatal pneumonia.

(8) **Sex.**—Males are more commonly attacked than females, the discrepancy in the relative number of cases being greatest from the twentieth to the fiftieth years of age, and being due to the more frequent abuse of alcohol by men and the greater liability to exposure.

(9) **Race.**—The negro, American Indian, and the Eskimo are more susceptible to pneumonia than the white race.

(10) **Unhygienic Surroundings.**—The disease is more frequent among the lower than the higher classes—a fact due to the improved hygienic environment of the latter.

(11) **Circumstances Connected with Individuals.**—The alcoholic is especially prone to this disease. The increasing incidence of pneumonia is probably due in a measure to the recognized increase in frequency of the various forms of degeneration of the viscera, particularly of the heart and kidneys. Certain chronic diseases (chronic Bright's disease, organic heart affections, carcinoma, diabetes, etc.) exert an influence. Emigrants would seem to be more susceptible than persons who have become acclimated. Colonel Vaughn has shown that the majority of the cases of pneumonia which have occurred in American camps during the war were found among men who came from the rural districts. Cowles observed at the Groton School for Boys that an acute fatigue due to violent exercise was a contributing cause of pneumonia.

(12) **Prior Attacks.**—One attack undoubtedly leaves the system more susceptible to the disease, so that repeated attacks—ten or more—may occur in the same individual.

(13) There has been noted a marked increase in the number of cases of lobar pneumonia during the past quarter of a century. Wells has shown by statistical facts that the incidence of the disease has steadily increased during the last century.

Immunity.—The results of the investigations of Behring and Kitasato with the blood-serum of animals which had been immunized against tetanus and diphtheria led Drs. G. and F. Klemperer to experiment upon the lower animals with Fränkel's diplococcus. They found that the rabbit could be

¹ *Jour. Amer. Med. Assoc.*, 1919, lxxii, 252.

² *British Med. Jour.*, November 11, 1911.

rendered immune by intravenous or subcutaneous injections of large amounts of the fluid bouillon cultures or of the glycerin extract. From 10 to 20 c.c. of serum taken from a non-receptive animal were injected into the veins of an animal that was suffering from typical pneumonia (artificially produced), whereupon the symptoms subsided rapidly and the animal entered upon a speedy recovery. The same serum, used in a similar manner upon healthy receptive animals, rendered them non-receptive.

Clinical History.—*Prodromes* are rare, and when present consist of a slight general indisposition, lasting a day or more. Rarely, there is cough, thoracic oppression, and slight chest pains (simple bronchitis), that may or may not be connected with the pneumonic process. Here invasion may be marked by sudden great thoracic oppression or by a gradual development of the local and general symptoms without rigor.

Usually the *invasion* is *very abrupt* and marked by a severe *rigor*, which has a duration of from half an hour to an hour, during which period the patient feels most uncomfortable, and is, indeed, very ill. The initial chill may occur at any hour of the day or night, the *fever* rising immediately and rapidly, and the temperature often mounting to 104° F. (40° C.) or even higher in the course of a few hours. The *skin* becomes harsh and dry, the face flushed, and the cheek on the side affected often shows a circumscribed deep-red spot. *Prostration* is pronounced, and headache and other nervous disturbances (restlessness, delirium) accompany and follow the ushering-in symptoms.

The *thoracic symptoms* follow closely upon the termination of the chill. Inspiration, particularly if deep, causes a stabbing *pain* in the affected side; the respirations are hurried, somewhat jerking and shallow (panting), while the pain persists, and later *dyspnea* may become marked, with accelerated breathing. *Cough* sets in early, and is dry and painful during the first day or even longer, and may be attended with expectoration, which generally presents a characteristic *rusty* or *blood-stained appearance*. The *physical signs* rarely appear before the end of the first day, and sometimes as late as the third (central pneumonia); in the latter form the local symptoms, as cough, dyspnea, and sometimes pain, are either wanting or feebly expressed during the first three or four days, and the clinical picture is composed of the general features only.

Anorexia is usually complete; *thirst* is excessive, and commonly there is *vomiting* at the onset, the bowels being generally constipated, though diarrhea may not infrequently be present. The patient in most instances lies upon the affected side until the pain has in great part subsided, and then he is apt to assume the dorsal position, exposing to full view an *anxious countenance*, with a characteristic *flush* upon the cheek, while the *alæ nasi* are seen to dilate forcibly during inspiration. Very frequently *herpes* on the lips or nose appears about this time, and forms a valuable diagnostic symptom. The nocturnal remissions are slight, the temperature being of the continued type, and the fever continues high—104° to 105° F. (40°–40.5° C.)—for from five to ten days, and generally terminates by crisis. The pulse is somewhat quickened, but the *pulse-respiration* ratio is not maintained. The other general features last until the crisis occurs, or even increase in severity, but do not outlast this period; many of the local symptoms, however, and particularly pain, are greatly improved before the crisis is reached.

As will be seen hereafter, the general course of pneumonia is modified by a variety of interfering conditions that have relation to complications, individual circumstances, severity of the type, etc. In the instances in which the crisis is reached convalescence is rapidly established. The crisis may be accompanied by special symptoms, as copious sweating or diarrhea.

LEADING SYMPTOMS IN DETAIL.—Local or Respiratory Symptoms.—Increased frequency of the respirations is a characteristic symptom, the rate varying from 40 to 60 per minute in adults, and in children from 60 to 90 or more. It is panting in character, particularly when pneumonia occurs in

years; lower right lung affected. Blood, tem-

 pulse;
 respiration;
 Fig. 9.—Chart of a case of lobar pneumonia with

old subjects, and both inspiration and expiration are brief, though sometimes separated by a rather long pause. Expiration is usually accompanied by an audible "grunt," indicating great oppression, and while actual dyspnea is a frequent symptom, it may be absent, or as the case progresses may become either increased or greatly diminished according to the severity of the type.

The *chief causes* of the rapid and labored breathing are the involvement of a large portion of the lung, associated general bronchitis, pericarditis or extensive pleurisy, cardiac failure, collateral congestion with edema, fever, and the intense pain in the side. The odor of acetone is sometimes detectable upon the breath in advanced cases.

The *pulse-respiration ratio* is disturbed, the relation now being 1 to 2, or even 1 to 1.5, instead of 1 to 4, as in health (Fig. 9).

Pain in the affected side is in most cases developed within a few hours after the initial chill, and after lasting two or three days gradually disappears. It is stabbing in character, and usually referred to the region immediately below the nipple or to the axilla, and rarely to other points (abdomen, flank—the so-called *abdominal symptom*). In most instances it is not severe until greatly intensified by the cough, which always aggravates this symptom, as does deep inspiration. The pain is due to implication of the pleura covering the inflamed lung, and may be entirely absent, especially in the aged and those showing marked toxemia.

The *cough*, like the chest pain and respiration, is somewhat characteristic, being frequent, short, dry, and voluntarily repressed, because it is attended with increased suffering. Yet there are cases that run their entire course without cough—*e. g.*, in the aged and in drunkards.

The Sputum.—At first mucoid and frothy, it soon becomes of a characteristic *rusty* color. It consists of a frothy, fluid mucus containing an abundance of small viscid masses of a yellowish- or reddish-brown color, from admixture of blood. The chief peculiarity of the sputum in fully developed cases is its *viscosity* and *tenacity*, often adhering to the receptacle even though the latter be inverted; owing to its adhesive quality it is ejected from the mouth with considerable difficulty by the patient. About the time of the crisis the sputum usually becomes more abundant, distinctly purulent, and its expulsion easy, but rarely it may be absent after the crisis. In severe types of the disease it may, at the outset, consist largely of pure blood, and in adynamic forms it is often thinner and darker in color (*prune juice*). There are cases in which there is an abundance of mucopurulent expectoration when extensive associated bronchitis occurs, and, on the other hand, instances are met with in which nothing is expectorated save a little light-colored mucus. In old persons or in those previously enfeebled there may be no expectoration whatsoever. The amount is, therefore, exceedingly variable.

Under the microscope the sputum is seen to contain red blood-corpuscles, alveolar epithelium, the *Micrococcus lanceolatus* (usually with other microorganisms), pus-corpuscles, and small fibrinous casts.

GENERAL FEATURES.—The Fever.—As I have already stated, the fever rises rapidly during the initial chill, so that in eight to twelve hours the temperature reaches 104° or 105° F. (40° or 40.5° C.). It then remains high until the crisis, pursuing the continued type, with nocturnal remissions amounting to a degree or over, while the daily fluctuations correspond with the normal, except that they are now somewhat exaggerated. In children the rigor is almost always replaced by convulsions. The temperature has a lower average range in persons previously debilitated, in old people, and in drunkards than in healthy adults and children. During the febrile period there may be observed a pronounced fall of temperature—pseudocrisis—but the temperature again rises to its former height. This may occur quite early, though more often it precedes the true crisis by a day or two; and rarely it may take place repeatedly, and the temperature-curve bear a strong resemblance to the remittent or even the intermittent type, regardless of any malarial infection. The temperature may be unusually high, 106° F. (41.1° C.) or even 107° F. (41.6° C.), these striking

ture, etc., in pseudocrisis, while it disappears with the true crisis. Stienon finds that in the febrile stage the polynuclear cells are enormously increased, both relatively and absolutely, but as soon as these diminish the eosinophiles, previously absent, begin to increase. A small percentage of myelocytes may be found. Slight leukocytosis may indicate a mild infection, but, as a rule, it is a bad prognostic sign. Leukopenia occurs in the malignant cases; on the other hand, leukocytosis of high degree, while indicating a severe infection, "it, at the same time, shows a good reaction." Leukocytosis, however, may be prevented by previous infections (*e. g.*, typhoid) and the use of internal antipyretics. The pneumococci may be agglutinated by the serum of pneumonia patients.

The red corpuscles and hemoglobin remain little changed during the fastigium, but show a marked decrease almost immediately after the actual crisis. The blood-plates are also increased in number (Hayem).

Cerebral Symptoms.—*Headache* sets in early and may be a prominent and persistent feature. In many cases, and particularly in children, the disease is ushered in by convulsions, this symptom occurring more often in the apical than in the basilar form of pneumonia. *Delirium* may come on during the acme of the disease (rarely, it may start as an acute mania), and may assume a maniacal form, but oftener in my experience consciousness has been retained. In the drunkard *delirium tremens* usually develops, and may anticipate the symptoms referable to the lungs; and I fully agree with Osler in stating that it should be an invariable rule, if fever be present, to examine the lungs in delirium tremens. These cases may often be appropriately termed *walking pneumonia*, since they go about until excitement gives way to a coma that deepens into death. In *adynamic forms* a low, muttering delirium and coma are frequent.

In the so-called *cerebral pneumonia* the nervous phenomena are quite pronounced, and simulate closely cases of cortical meningitis. It is often associated with excessively high fever except in the aged, when the cerebral symptoms are also well marked, but the fever is moderate. Apical pneumonias are apt to assume the cerebral type, but in my experience this dictum is correct as relating to children only. Double pneumonias are commonly characterized by severe cerebral symptoms.

The Cutaneous Symptoms.—As stated before, herpes is common and its diagnostic importance is considerable. *Nasolabial herpes* is but little less frequent in this disease than in malaria, being present in about one-third of the cases. It usually comes out from the second to the fifth day of the disease, and rarely may appear upon the cheek, lobe of the ear, the genitals, forearm, or upon the mucosa of the tongue. Sweats are not common except at the time of the crisis, when they may be copious. The deep-red circumscribed spot upon one cheek (*mahogany flush*), usually on the side of the affected lung, has already been mentioned. Urticaria has been observed, though rarely.

Digestive System.—The mouth is dry, the tongue has a coating of a yellowish-white color, becoming dry and brown in cases representing a low form, and anorexia and thirst are present. *Vomiting* is not uncommon at the outset, and may be repeated, while constipation is the general rule and diarrhea the frequent exception. Sears and Larrabee in an elaborate analysis of 949 cases found that pain below the costal margin was frequently present, and in several cases appendicitis, especially when the pain was associated with muscle spasm. Splenic enlargement of slight degree can usually be detected on palpation.

Urinary Symptoms.—The urine is febrile, diminished in amount, and high colored, the urea and uric acid being greatly in excess. On the other

hand, the chlorids are, according to the older authors, either diminished in amount or absent during the febrile stage, presumably for the reason that they pass into the inflamed lung tissue. They are not, however, constantly absent, and sometimes they are not even lessened in pneumonia; moreover, their disappearance is not peculiar to this disease. The above-mentioned facts justify two important inferences: (1) The absence of chlorids is a symptom of little diagnostic value; and (2) their reappearance in the urine toward the close of pneumonia is of small prognostic worth. Slight (febrile) albuminuria is common. Ketonuria may be noted.

PHYSICAL SIGNS.—Stage of Congestion.—The density of the lung is increased, but the involved tissue is not consolidated and the pleura is not yet covered with fibrin.

Inspection.—The movements of the affected side (especially if the base be involved) are defective, the degree of expansion being much diminished. In double pneumonia the costal type of breathing, combined with a vigorous play of the abdominal muscles, is observed.

Palpation.—There is a slight increase in the tactile fremitus over the congested area, and defective expansion is noted.

Percussion.—The note may be normal, though more often it is briefer, higher pitched, or even distinctly tympanitic.

Auscultation.—The breath-sounds are weak, and sometimes become bronchovesicular upon deep inspiration, while over the unaffected lung tissue they are exaggerated. If, as often happens, inflammatory products due to associated bronchitis occupy the small bronchi, subcrepitant râles may be audible. The crepitant râle, however, is rarely heard until the close of the first stage.

Stage of Consolidation.—Inspection.—There is little or no expansive motion of the chest over the affected area, while upon the unaffected side it is increased. The volume of the thorax on the diseased side is increased, as shown by mensuration, but the intercostal depressions are not effaced.

Palpation renders clearly perceptible the defect or absence of expansion. Vocal fremitus is usually much increased, though in exceptional instances it is diminished or absent—a circumstance which can, as a rule, though not invariably, be attributed to an associated pleurisy with more or less effusion. Frequently a friction-rub is felt before complete consolidation is established.

Percussion.—Varying degrees of dullness are obtained in this stage, and before the lung tissue becomes thoroughly solidified the note may have a tympanitic quality. After complete consolidation there is usually marked or absolute dullness posteriorly, unchanged by full inspiration, while the note may be more or less tympanitic anteriorly, where the vibrations are more apt to reach the air in the larger bronchi. A sense of resistance is offered to the pleximeter-finger, but not to the same degree as in the case of a pleurisy with effusion. When the latter condition is associated and in massive pneumonia the percussion-note will be flat. Deadness is less marked in old people in whose ribs senile changes have taken place, which render them more resonant, or in cases in which the consolidated areas occupy the central portions of the lung. Above the solidified part skodaic resonance is usually obtainable.

Auscultation.—Bronchial or tubular breathing is heard, as a rule, over the solidified lung, but it may be absent in consequence of the plugging of the large bronchi with exudate (so-called *massive pneumonia*). Bronchophony is usually obtainable over the portion of the lung affected, though this may also be absent, and for the same reason as in the case of the bronchial breathing: it sometimes takes the form of egophony. Subcrepitant râles, due to

associated bronchitis, are sometimes heard with unusual distinctness (owing to the consolidation), and the crepitant râle at the end of inspiration is best heard at the beginning of consolidation, when the pleura receives its coat of fibrin and while the lung is yet capable of sufficient movement to produce fine pleural friction. A distinct friction-rub may also be heard occasionally.

Stage of Gray Hepatization.—With beginning resolution the solid contents of the air-cells liquefy and are removed, so that air now re-enters the air-cells and permits a consequent increase in the movement of the lung.

Inspection.—The normal expansile movement gradually returns.

Palpation.—Tactile fremitus progressively diminishes.

Percussion.—The dull or tympanitic quality of the note is gradually lost, though the fact must be emphasized that the abnormalities in the note vanish more slowly than the other abnormal physical signs. Some degree of deadness often remains long after apparent recovery.

Auscultation.—With increased movement of the lung there may be a re-appearance of the crepitant râle, due to interplay of the pleural surfaces, and the softened exudate in the air-cells gives rise to subcrepitant râles, heard both on inspiration and expiration (*râle redux*), with coarser râles over the bronchi. Bronchial breathing gradually gives place to bronchovesicular, and the latter, in turn, to normal, breathing.

The Pneumococcus Septicemia.—The pneumococcus infection may cause severe toxic features and even speedy death without any, or with but little, involvement of the lung texture. The general *invasion symptoms*, such as the chill, high fever, and nervous symptoms which always predominate, however, are present and persist until death ends all. Death is preceded by signs of cardiac failure, by vasomotor paresis, or, more rarely, by coma. In some of these cases localization of the morbid process may occur in organs other than the lungs, as the cerebral meninges, the endocardium, pericardium, and the pleura. An assured diagnosis in these atypical forms of the pneumococcus infection can be arrived at by a bacteriologic examination of the exudate obtained by aspiration. The pneumococcus can also be demonstrated in blood-cultures, provided that they are made with large quantities of blood.

Complications.—Many of these are due to the primary infection.

Pleurisy is, of necessity, associated in all instances in which the consolidation reaches the pleura. In most cases the presence of the diplococci has been demonstrated. Cases are met with in which the truly pneumonic symptoms are overshadowed by the intensity of the pleuritis, and to these the term *pleuropneumonia* has been applied. There is often a copious effusion which is exceedingly rich in fibrin—a circumstance which distinguishes it from other forms of acute pleurisy. There may be the ordinary grade of pleurisy on the side of the pneumonia, and a severe grade on the opposite side which is apt to be purulent. Indeed, empyema has of late been shown to be a frequent complication of pneumonia, and it also occurs as a sequel. Anders and Morgan¹ in a statistical study of 2512 cases of pneumonia found that a serofibrinous pleurisy occurred in 198 cases and empyema in 68. The relative incidence of empyema complicating pneumonia was 50 per cent. in 115 cases at Camp Custer (Beals, Zimmerman, and Marlow). A condition that affects its incidence is involvement of the lower right lobe. Lambert and Daly report 5 cases of empyema developing as a complication in lobar pneumonia which showed a sudden rise of leukocytosis to nearly or more than double the count of the previous day. Its development is accompanied by replacement of ordinary dullness by flatness with great resistance, and by the disappearance of râles and

¹ *Jour. Amer. Med. Assoc.*, 1911, lvii, 1204.

breath-sounds, normal and abnormal. Other characteristic features of empyema are present. In all cases in which the presence of a pleural exudate is strongly suspected during the course of pneumonia, needling should be resorted to without delay.

There is a prompt rise of fever, the temperature leaping to 103° or 104° F. (39.4° or 40° C.) quickly, after which it is decidedly remittent in type, but there are no hectic chills. Fistulous connection with a bronchus, however, and the establishment of *empyema necessitatis* are common events, and may be preceded by diurnal chills, sweats, etc.

The occurrence of *septic phenomena* is a certain indication of secondary infection by streptococci. The pus is rarely absorbed and frequently becomes encysted. I saw one instance in which the effusion measured 8 liters, while ordinarily the amount ranges from 2 to 5 liters. Removal of the effusion by aspiration is promptly followed by the disappearance of the fever, but reaccumulation generally occurs.

Finally, if defervescence in pneumonia takes place by lysis or if an irregular fever persists, a residual purulent or serofibrinous effusion may be considered as the likely cause. This latter complication is attended by a paroxysmal cough which is excited by movement, and is not usually accompanied by expectoration.

Acute general bronchitis may pre-exist or arise as a complication, and often proves formidable, intensifying the fever and increasing the dyspnea, the tendency to heart failure, and the cyanosis. The expectoration is freer than in uncomplicated pneumonia, and over the bronchi moist râles intermingled with sibilant and sonorous râles are audible.

Pericarditis.—This is an important and serious complicating affection. According to Chathard, it is oftener synchronous with involvement of the right than of the left lung, hence arises as often by a metastatic process as by direct extension. It was present in 4.66 per cent. of 665 cases and occurred most frequently in young adults. Although generally of the plastic variety, it is not infrequently serofibrinous, and rarely the effusion is purulent. Stowe¹ during the epidemic of pneumonia in the first year of the war had the opportunity of observing 300 autopsies on patients dying of pneumonia. His statistics show that pericarditis occurred as a complication in 72 (24 per cent.) of the cases. Of these 72 cases, 19 per cent. had an acute serofibrinous pericarditis; 19 per cent., a subacute fibrinoplastic and purulent type, while the remainder (61 per cent.) were acute purulent effusions. There was about an equal involvement for the two lungs, but “pericarditis occurred only one-eighth as frequently in patients without empyema as in patients with empyema.” The *diagnosis* can be made here as under other conditions (pericardial friction-rub, etc.), but the complication is often insidious. The occurrence of increased dyspnea, with or without precordial pain, should serve as a signal and lead to a physical examination.

Endocarditis.—Preble has well said that endocarditis should always be suspected in a case of pneumonia, which is followed by an irregular temperature not sufficiently accounted for by some other complication, such as empyema. Out of 209 cases of malignant endocarditis collected by Osler, 54 cases occurred in pneumonia. Endocarditis complicates pneumonia in 1 per cent. of all cases and in 5 per cent. of the fatal cases (Preble). It is generally of the malignant type and may attack any valve (the aortic leaflets, however, being most commonly affected). There are no reliable symptomatic indications of this condition. The physical signs must be faithfully and systematically noted.

¹ *Jour. Amer. Med. Assoc.*, 1919, lxxiii, 254.

Frequently murmurs are absent; and, on the other hand, the presence of a murmur alone is by no means diagnostic of the complication. Bradycardia is not uncommon, but oftener the pulse is rapid and feeble. The development of septic manifestations, especially irregular fever, chills, and sweats, renders the case highly suspicious, and when, in addition, there arises distinct evidence of embolic processes the diagnosis becomes highly probable. If, now, the symptoms of meningitis supervene, little doubt remains as to the character of the complications, since meningitis and endocarditis are often combined in pneumonia.

Netter, Weichselbaum, and Bignami have shown that acute endocarditis may be caused directly by the diplococcus of pneumonia.

Chronic Endocarditis.—Pneumonia arising in the course of chronic endocarditis is apt to be attended by cardiac failure, with ensuing venous stasis. The murmurs of chronic valvulitis often disappear with the development of pneumonia.

Cardiac clots (antemortem) may form, but are rare. They result from weakness of the ventricular wall, especially in the right heart; and are most apt to arise, therefore, in cases in which the preagonal period is much prolonged. Venous thrombosis is rarely seen, and embolism of the larger arteries is a rare complication. Cerebral embolism, causing aphasia, has been observed but seldom. Pneumonic hemiplegia, either without gross cerebral lesions or from a larval meningitis, rarely occurs.

Pneumococcus meningitis may be a complication; it differs only in the bacteriologic findings from meningococcus meningitis. Pneumococcus meningitis may also occur independently of lung involvement.

The symptoms are not clearly defined; particularly is this true when it develops during the invasion period and the basilar meninges are not involved. The presence of intense and persistent headache, rigidity of the nucha, wild delirium followed by stupor, deepening into profound coma, affords a basis for a probable diagnosis. Its frequent association in the purulent form with ulcerative endocarditis has been pointed out above. The cerebrospinal fluid contains no sugar in this condition.

Peripheral neuritis is among the rare complications of this disease.

Parotitis is also sometimes seen, and may cause a fatal termination of the case. I have seen two instances, however, in which this was a complication, and both ended in recovery. It is thought to be associated usually with endocarditis, but not so in my cases.

Arthritis.—A pneumococcic arthritis occurs, but it is rare. The joint is occasionally primarily involved, showing the importance of toxemia (Herrick). It is most prone to develop after the crisis, and is associated with meningitis and endocarditis. The exudate is generally a thick creamy pus, less commonly serofibrinous. The changes may be either slight in the acute forms, or extensive and destructive of cartilage and bone, particularly in the more chronic cases. A recognition of the condition demands exploratory aspiration and bacteriologic examination. The mortality rate is 65 per cent. *Rheumatism* and *otitis media* may be rarely met also, particularly in children. The pus in complicating otorrhea should be examined for concomitant organisms.

Gastro-intestinal Complications.—*Croupous gastritis* may rarely intervene. Fussell¹ calls attention to complicating *acute dilatation of the stomach*; it causes vomiting, sudden epigastric distention becoming general, and collapse, which is an urgent symptom. *Croupous colitis* is a frequent concomitant, sometimes grave, giving rise to tympanites and diarrhea. *Tympanites*, due to paresis of the intestinal muscularis, may occur and is a serious complication.

¹ *Amer. Jour. Med. Sci.*, December, 1911.

(5) **Bilious Pneumonia** (*Malarial Pneumonia*).—In pneumonia occurring in malarial subjects the initial chill is prolonged and the fever paroxysmal or remittent. Jaundice and vomiting are common.

(6) In **children** the first symptom is often a convulsion. Cerebral symptoms (delirium, stupor, coma) may appear early. The upper lobes of the lungs are frequently involved. Unless the objective indications be examined for, the disease is frequently overlooked. The characteristic sputum is rarely seen in juvenile pneumonia. Crozer Griffith reports 8 cases in which the pain suggested appendicitis.

(7) In **old persons** the initial chill is often absent or replaced by moments of chilliness. There may be nausea and vomiting. Prostration is profound; there is fever, but it does not range high and is irregular. Nervous phenomena, sometimes prominent, are not uncommon, but the local symptoms (cough, expectoration, and pain) are mild or wholly absent. The physical signs are defective owing to impairment of the respiratory movements; dulness on percussion (with a tympanitic quality), tubular breathing, and a few subcrepitant râles may, however, be noted. This affection is a most deceptive one in old people, the cases generally ending fatally after an illness of an apparently mild degree of intensity.

(8) **Abortive pneumonias** last longer than twenty-four or forty-eight hours. The general features are rigor, high fever, and defervescence by crisis with profuse sweating. The sputum is rarely characteristic, and the physical signs variable; typical tubular breathing is rare, while râles and pleural involvement are common. Bechtold has frequently observed this form affect all the members of a family.

(9) **Terminal Pneumonia**.—Many instances of pneumonia are discovered in the postmortem room. These arise in advanced cases of chronic pulmonary tuberculosis, organic heart diseases, chronic Bright's disease, diabetes, and the like, and manifest no clinical symptoms other than slight elevation of temperature, an increase in the respirations, and lung consolidation. A fatal termination is the rule in terminal pneumonia.

(10) **Ether-pneumonia**.—Opinions are divided as to the frequency of occurrence of pneumonia after ether-narcosis. The aggregate number of cases from all sources (57,842) gives a percentage of 0.07. My own statistics, embracing 12,842 cases, give a percentage of 0.23.

The principal causes are: (a) Season. According to my investigations, over 80 per cent. of the cases occur during the winter and spring months. The patient is sometimes carried from a heated operating theatre through a cold corridor to a room or ward with a lower temperature. (b) "Catching cold," or exposure as may obtain during protracted operations. (c) Bronchitis, coryza, and the like present at the time of anesthesia. (d) Dried secretions or incrustations of foreign matter that are loosened by the ether and drawn into the lungs. (e) Abdominal operations give the highest percentage of cases, due, as my studies show, to the more protracted etherization. Mikulicz has shown that ether-pneumonia following these operations is caused by embolism. (f) Graves¹ believes that most cases are caused by the lighting up or aggravating of pre-existing foci in the lungs. Recently some statistics have been brought forth as to the frequency of postoperative pneumonia after various types of anesthetics. It was found that after ether chloroform and nitrous oxid anesthesia the percentage of postoperative pneumonia showed but slight differences. There is a much greater incidence of pneumonia after abdominal and septic operations than with clean operations that take equally as long, *e. g.*, carcinoma of breast. Postoperative pneumonia is apparently

¹ *Boston Med. and Surg. Jour.*, September 29, 1910.

not an inhalation pneumonia, but is due to septic emboli carried from the operation site to the lungs.

The *clinical features* are aptly compared with those of secondary pneumonia (*vide* p. 121). The *diagnosis* rests principally upon the typical physical signs. Owing to the extreme latency of the condition, and the danger that the symptoms may be regarded as being septic in nature, I would emphasize the importance of a physical examination of the thorax upon the sudden accession of *fever*, particularly if associated with thoracic *pain*, however slight, following an operation.

Relapses.—These are rare, and are usually rudimentary. *Recurrences*, however, are ordinary (*vide* Predisposing Causes, p. 100).

Course and Duration.—In most instances the crisis occurs on the seventh or ninth day, and resolution is completed about one week later, making the total duration from twelve days to two or three weeks. Convalescence, however, may be delayed by complications or sequelæ, and fatal cases are apt to terminate on the seventh, eighth, or tenth day.

SEQUELÆ.—(a) **Delayed Resolution.**—The process of resolution may not begin until the fourth, sixth, or even tenth week. Usually defervescence by crisis has taken place long before the physical signs indicate resolution; the fever may, however, fall by lysis. When resolution occurs it may lead to complete restoration of the anatomic entirety of the lung tissue. Delayed resolution is often confused with certain sequelæ, especially empyema. Rarely proliferation of the interstitial connective tissue arises in postponed resolution, producing (b) **chronic interstitial pneumonia**. (c) **Abscess**; (d) **gangrene**; and (e) **tuberculous phthisis** are also sequelæ.

Diagnosis.—This is determined by special local and general symptoms, together with the physical signs. Of these, the abrupt onset with rigor, the course of the fever with termination by crisis, the abnormal pulse-respiration ratio, anxious countenance, stabbing chest pains, rusty expectoration, expiratory “grunt,” leukocytosis, and the signs of lobar consolidation are the most characteristic. Isolation of the pneumococcus from the urine may be a great aid in the diagnosis. Repeated physical examinations of the chest will often detect consolidation in the absence of the accustomed symptoms. Again, when in the course of certain chronic affections (cancer, Bright’s disease, diabetes, and organic affections of the heart) fever is developed, physical exploration of the thorax is demanded. A Roentgen-ray examination may show a limited pneumonic consolidation in cases in which the physical signs are indicative only of bronchitis.

DIFFERENTIAL DIAGNOSIS.—This relates to (a) acute pneumonic phthisis, (b) meningitis, (c) bronchopneumonia, (d) acute pleurisy with effusion.

(a) PRIMARY LOBAR PNEUMONIA

There may have been prior attacks.

Sudden, with severe rigor and rapid rise of temperature.

Fever of continued type, terminating by crisis.

No drenching sweats except at time of crisis.

Herpes common.

Not much emaciation.

Pulse-respiration ratio much disturbed.

Sputum rusty colored, viscid, and sticky; contains pneumococcus.

ACUTE PNEUMONIC PHTHISIS

Inherited predisposition or previous tuberculous disease.

Generally more gradual—repeated fits of chilliness (rarely severe rigor), often following exposure or “cold.”

Fever of remittent type, often becoming intermittent, without crisis.

Drenching sweats present and oft repeated.

Absent.

Rapid emaciation.

Less so.

Sputum may be blood-tinged; is more purulent and copious, and contains numerous bacilli and yellow elastic tissue.

(a) PRIMARY LOBAR PNEUMONIA

Leukocytosis present.
 Duration of febrile stage shorter.
 Physical signs, as a rule, first referable to base of lung.
 Usually limited to one lobe or the lower segment of one lung.
 Signs of consolidation, followed by resolution.
 Apex of opposite lung not involved.
 Prognosis not hopeless.
 Tuberculous disease of other organs does not follow as a rule.

ACUTE PNEUMONIC PHTHISIS

Relative lymphocytosis.
 Duration longer.
 First referable to apex.
 Usually extension from apex to base.
 Signs of consolidation, followed by cavity formation, with large gurgling râles at apex.
 Apex of opposite side generally invaded.
 Hopeless.
 Often does.

(b) *Meningitis* is sometimes mistaken for pneumonia, and particularly when the latter occurs in children. The initial symptom of pneumonia in the very young is often a convulsion; whereas, though in meningitis this symptom is not uncommon, it is more apt to manifest itself later. When headache

Fig. 10.—Lobar pneumonia: 1, Unaffected area (upper lobe); 2, consolidated area (middle lobe); 3, resolving area (lower lobe); 4, heart in normal position.

occurs in pneumonia it is frontal. It is almost invariably complained of in meningitis, but is occipital, and is associated with rigidity of the cervical muscles. Before the occurrence of pressure-symptoms in the latter disease the patient is very restless and morose; his reflexes are exaggerated and there is marked hyperesthesia. The temperature-range is lower, more irregular, and there is no crisis, while the pulse is more variable and often irregular in meningitis. In pneumonia with latent local symptoms the pulse-respiration ratio is greatly altered and the type of respiration peculiar (*vide ante*). The

(a) the temperature range, (b) the degree of heart power, (c) the intensity of the nervous symptoms, and to some extent by (d) the size of the area of lung induration. It is a matter of common observation that the absence of leukocytosis is indicative of a grave type. In case the diplococcus be found in the blood, the prognosis is considered grave, and it is to be recollected that with the improved technic of the present day this organism is readily isolated.

(a) *The Temperature Range*.—A continued high temperature, as, for example, 105° F. (40.5° C.), on two or three consecutive days without material remissions, is ominous. (b) *The Degree of Heart Power*.—A steadily rising pulse-rate after the fifth day indicates real danger, since it points indisputably to gradual cardiac failure. The same thing is shown by a diminution in the intensity of the second pulmonary sound. A decreasing pulse-pressure means cardiac failure. (c) *The Intensity of the Nervous Symptoms*.—Active delirium is not favorable at any stage, and is particularly unfavorable if it develops early. When it assumes the form of delirium tremens the case has usually passed beyond the hope of recovery. (d) *The Size of the Area of Lung Induration*.—I have observed that extension of the consolidation at an advanced stage belongs to serious types. The same may be said of double lobar pneumonias.

(2) **Presence or Absence of Complications**.—Involvement of a single lobe or two lobes, if it occur on the right side and without complications, generally terminates in recovery. In nearly one-half of the instances complications occur, and these greatly increase the death-rate. Among the most common is *pleurisy*, which, unless accompanied by considerable effusion, does not add fresh danger; when pleurisy attacks the non-affected side, however, it does. *Empyema*, following pneumonia, generally terminates in recovery unless septic phenomena are superadded. Extensive *bronchitis* is a most perilous complication in my judgment. *Pericarditis* decreases the chances for recovery, but by no means to the same extent as *ulcerative endocarditis*. *Cardiac clots* may form, but usually the patient is already moribund. *Abscess of the lung* and *gangrene* form unfavorable complications. *Congestion* and *edema* of the uninvaded portions of the lungs render the outlook bad, and these, together with cyanosis, are dependent upon failure of the heart. *Marked tympanites* is attended with danger. *Acute meningitis* is exceedingly grave. Fenwick, as the result of an analysis of 10,000 cases, found that the quantity of albumin in the urine is of considerable prognostic value. *Gastro-intestinal complications* occurring at the outset are unpropitious.

(3) **Circumstances Connected with the Individual**.—Of these, *age* heads the list, and after the twentieth year the mortality increases progressively until the seventh decade, when it rises more abruptly. It has been claimed that nine-tenths of the deaths after the seventy-fifth year are from lobar pneumonia. Under the twentieth year, according to the analysis of 708 cases at St. Thomas' Hospital by Hadden, H. W. G. Mackenzie, and W. W. Ord, the mortality is 3.7 per cent.

Sex has little influence. Napier's figures, however, indicate that pneumonia is a more deadly disease in men than in women. The *alcoholic* rarely escapes death, and *adiposity* is an unfavorable condition.

(4) **Type of Organism**.—The prognosis of a Type I infection not treated by serum is, according to the statistics of the Rockefeller Institute, 25 per cent., while only 7.5 per cent. of the patients die who have had serum. However, the mortality rate of Tenney and Rivenburg,¹ in a series of 101 serum-treated cases, was 14.7 per cent. The mortality rate in Type II is 36 per cent., again quoting the Rockefeller statistics, while Type III infection is the most lethal, 47 per cent., and Type IV, uncomplicated, is but 6 per cent.

¹ *Arch. Int. Med.*, 1919, xxiv, 545.

Modes of Death.—Death is due to: (1) Overwork or overdistention of the right ventricle; (2) mechanical interference with respiration (rare); (3) pneumococcus infection of other organs, as the meninges, pleura, pericardium, endocardium; (4) pneumococcus toxemia and septicemia, *progressive heart weakness*, tympanites, and diarrhea; (5) vasomotor paresis.

Treatment.—Prophylaxis.—The pneumococcus is undoubtedly most frequently conveyed by droplets of moisture coughed or sneezed into the air by a carrier of the organism and inhaled by another individual. Proper preventive measures require (1) that healthy individuals, whether or not carriers, should cover the mouth when coughing or sneezing; (2) that patients ill of or convalescing from pneumonia should cough into gauze which can be subsequently burned; (3) that attendants of such patients should be protected by face masks of gauze from getting the disease or at least prevented from carrying the germs to those less resistant.

The face mask must cover the mouth and nose. It must be sufficiently thick to prevent the germs even entering or leaving during explosive coughing or sneezing; it must not be too heavy so as to be a discomfort. Doust and Lyon¹ recommended the use of three layers of butter cloth. Haller and Colwell² experimentally have shown that a mask to protect should be of three to four thicknesses of gauze. If the infected are masked, six to seven layers are necessary to prevent droplet infection to others. The masks should be 8 inches in length and 5 in width, with the edges turned in and stitched. Tapes are sewed along the upper and lower edges and are tied behind the head, all used to secure the mask firmly on the face.

Sailer and his co-workers³ have very definitely shown "that carriers are an important factor in the spread of pneumonia." Furthermore, the detection of carriers is relatively easy, and as vaccination is impossible in Group IV carriers, owing to the diversity of this group, vigorous antiseptic treatment should be instituted. For this purpose the authors recommend 3 per cent. phenol in liquid petrolatum, 2 drops in the nose and the mouth, swabbed twice daily; 5 per cent. tincture of iodine in the same vehicle gives equally good results.

General Management.—The patient should be isolated in a well-aired apartment or, better still, kept out-of-doors. The roof is frequently fitted up in some institutions with a protection where the patient may have his nursing care, but the remainder of the time being spent out-of-doors. In private houses a protected porch may be used or, failing this, the windows may be kept open practically constantly. The open-air treatment improves the appetite, diminishes the temperature and pulse-rate; in short, lessens the toxemia, hence should be strongly advocated. Cases complicated with bronchitis or nephritis, however, should not receive the fresh-air treatment.

Spolverini points out that the pneumococcus in the sputum may remain virulent from fifty-five to one hundred and forty days, hence it is important to sterilize pneumonic sputum. An antiseptic mouth-wash should be advised. In severe forms the constant presence of a physician is required. The patient must be kept at *perfect rest*, and not allowed to leave his bed for at least one week after the occurrence of the crisis. The beneficial effects of rest, in the fullest sense, are not appreciated to the extent they deserve. The principal object of treatment is to support the powers of life until the crisis is passed.

The **diet** should be light, chiefly liquid, but of the most nutritious sort. *Milk* should constitute the chief article of diet; meat-broths or meat-juices, egg-white, and the like may be allowed. Cornwall emphasizes the value of a

¹ *Jour. Amer. Med. Assoc.*, 1919, lxxi, 1216.

² *Ibid.*, p. 1213.

³ *Arch. Int. Med.*, 1919, xxiv, 600.

non-putrefactive diet. The food, particularly the milk, is to be administered at stated brief intervals and in definite quantities. When resolution is delayed stronger forms of nourishment (scraped meat, etc.) may be given. After the crisis a gradual return may be made to the usual forms of solid foods. Page and others advocate abstinence from practically all nourishment *except water*.

The *medicinal treatment* is that of a *toxemia*, although the patient himself is the main factor. The use of calomel in fractional doses or one of the saline laxatives in the early stage is advisable. Subsequently the liver and bowels must be kept acting freely by means of a soap-suds enema daily, if required, so as to eliminate waste products and to obviate "absorption of fermentative products from the alimentary canal" (Thornton). The action of the kidneys is best maintained by the regular use of water, and that of the skin by sponge-baths. Stockton advises stimulation of the eliminative organs—skin, liver, kidneys—in senile pneumonia.

Stimulants are often indicated. It is well to begin their use as soon as the slightest tendency to cardiac failure or exhaustion is shown. When the pulse becomes more accelerated and feeble, the first sound of the heart less distinct, and the second pulmonic sound loses its accentuated character, or marked nervous symptoms or adynamia appear, then stimulants must be used. Alcohol was formerly extensively employed, but the present-day teaching is distinctly against its use except to those who are habitual users of alcoholic stimulants, when it may ward off delirium. It causes no rise in systolic blood-pressure, raises the diastolic pressure and lowers pulse-pressure, and decreases markedly cardiac efficiency. In the pneumonia of drunkards its early use is to be recommended.

Of the other stimulants, strychnin, though not truly a cardiac stimulant and having no direct effect on the heart or vasomotor system, has been serviceable in my own hands—at first in moderate-sized doses, to be increased as occasion demands. Should urgent need of stimulation arise, strychnin should be exhibited hypodermically. It is my custom in desperate cases to use subcutaneously as much as gr. $\frac{1}{15}$ (0.0043) every two or three hours. Critical studies upon the effect of strychnin on the heart and vasomotor systems, made during the past few years, show that it has no direct effect upon these two related systems. Its effect, if any, is indirect, probably through the stimulation of the nervous system. In severe forms of pneumonia digitalis is invaluable during the advanced stages; it may be given in doses ranging from 5 to 15 minims (0.3–1.0) of the tincture every third hour. In cases in which extreme cardiac weakness with depression of respiratory forces supervenes the drug is to be administered hypodermically in the same dosage. Strychnin may be combined with the digitalis. Cohn has shown that, contrary to the usual opinions, digitalis does affect the heart in pneumonia. By means of the electrocardiograph he has shown that digitalis therapy in pneumonia produces a decided prolongation of the P-R interval. In order to have the patient thoroughly digitalized, digitalis being slow in its action, he recommends large doses of digitalis, 1 c.c. four times a day, for the first three or four days of the disease. S. West sees most benefit from caffein citrate with nux vomica. Recent experience enables me to speak strongly in favor of atropin administered subcutaneously in the threatened collapse that sometimes attends the crisis. Nitroglycerin is especially indicated when the renal secretion is scanty and the urine contains more than the usual trace of albumin. Ammonium and camphor (gr. 1 to 2—0.06–0.12) in sterile oil or ether, hypodermically, are also excellent stimulants to the feeble heart of pneumonia. Leo¹ believes that camphor is able to kill the pneumococci

¹ *Münch. med. Woch.*, October 28, 113.

in the blood-stream and promote reabsorption of the pneumonic exudate. Weintraud has used intravenous injections of a 0.1 per cent. camphor solution, giving from 205 to 350 c.c. for the above purpose. Loeper and Furmonze advise intravenous injections of camphorated oil (2 c.c. of a 1 per cent. solution). Stine employs massive doses of camphor (gr. xxxvi—2.3) in sterile olive oil every eight hours in men and ten hours in women.

Peripheral stimulants, such as cold or heat, either locally or generally, are useful after the blood-pressure falls. To stimulate the vasomotor center, epinephrin (gtt. v of a 1 : 1000 solution, hypodermically, to be repeated as required) is advised. *Saline injections* are valuable in falling blood-pressure with increasing toxemia. A splendid method of stimulation is to give normal salt solution intravenously, about 500 c.c., and during the course of the slow transfusion inject into the lumen of the connecting rubber tubing 1 c.c. of epinephrin solution, according to a method recommended by Crile. It is thus followed and preceded by salt solution. Pitiutrin is another dependable and rapidly acting stimulant. Prolonged toxemia is frequently successfully combated by means of saline solution given by the drop method into the rectum. For an acute exacerbation of a chronic nephritis in the course of pneumonia venesection with saline infusion is worthy of trial.

Respiratory Stimulants.—Beginning cyanosis is the signal for the use of respiratory stimulants, of which the best are strychnin and atropin, and they should be given hypodermically. *Oxygen*, if given freely, often serves to tide over periods of marked cyanosis. The gas should be inhaled directly from the cylinder until relief is afforded, when it may be allowed to escape near the patient's nose, so as to become mixed with air. Cyanosis is nowadays a relatively rare occurrence, as most patients are treated by the fresh-air method so strongly advocated by Northrup.

Hydrotherapy.—In meeting high temperature, marked nervous symptoms, dyspnea, cardiac weakness, etc., hydrotherapy offers many superior advantages. When the temperature is high, ice-bags over the chest and abdomen are useful. Tub-baths should be omitted from consideration in the treatment of lobar pneumonia, rest being of the greatest importance. Cool sponging, combined with the ice-cap or the wet pack, serve as a substitute for the full baths (*vide* Local Measures *infra*), but should be employed only when the temperature is high 105° F. (40.5° C.).

Venesection.—This is a good measure in sthenic cases (which are not uncommon in rural districts), the temperature falling, the pain, the dyspnea, and the nervous symptoms being relieved, and the pulse softened. The bleeding, however, must be free and rapid. Later in the course of pneumonia venesection may be resorted to if cyanosis and the signs of collateral pulmonary edema—due to a failing heart—arise, but at this period bleedings rarely yield good results except in vigorous subjects.

Specific Therapy.—Washbourn, Pane, Fanoni, and others have reported favorable results from the use of *antipneumococcus serum*. It seems to possess considerable protective power, as shown by the Klemperer brothers (*vide* p. 100). Clinical experience indicates that an immune serum effective against Type I pneumococci has great value (Cole). White and others believe that the serum for Type II should also be employed, although it gives less positive results. Against the two other types, however, immune serums are not as yet of therapeutic importance. The Boards of Health of New York, of Philadelphia, and of other large cities now supply the immune serum prepared from Types I and II. The practitioner is obliged to send a specimen of the sputum, which is cultured, and if the infection is of these two types serum will be given for intravenous administration. The method of administration as

practised at the Rockefeller Hospital is outlined by Dochez¹ as follows: "The patient first receives 0.5 c.c. of horse-serum subcutaneously to test for hypersensitiveness. As soon as the type of organism has been determined and the danger of anaphylaxis ruled out, he receives intravenously from 50 to 100 c.c. of serum diluted one-half with freshly prepared salt solution. The dose is repeated twice daily until the condition of the patient indicates that no more serum is necessary. Usually from four to five such treatments are required." Friedländer and Runnels² twice observed slight reactions following the desensitization doses. In a certain number of cases there is a brisk reaction in about half an hour after the intravenous injection. The reaction is characterized by rise in temperature, followed often by a sweat and a fall of temperature to normal. There is usually a subsequent rise. In other cases defervescence occurs slowly, lasting several days. In still other cases the temperature-curve is uninfluenced and the crisis takes place at the expected time. It is important in the serum treatment of type pneumonias to determine first whether or not the hemolytic streptococcus is coexistent with type pneumococcus.

The use of killed cultivations, or *vaccines*, is found to be useful (Latham). Craig treated 20 cases in private practice with but 1 death, and pointed out that in hospitals they are not seen early enough. He states that the best method of procedure is to administer a polyvalent stock vaccine of the pneumococcus and streptococcus, of each 30,000,000, as early as possible. Make sputum smears and cultures—blood-cultures in early cases, lung punctures in late ones—and proceed to the preparation of an autogenous vaccine. If there is no definite response in twenty-four or forty-eight hours, repeat or, preferably, give an autogenous vaccine. If there is no response in thirty-six or forty-eight hours, double the dose. If there is a response, as evidenced by improved clinical symptoms and signs, defer re-inoculation three days, or until the first symptoms of retrogression in the general condition or the physical signs occur. Maintain the dosage or increase it every two or three days until the patient is entirely well. Generally about three doses are necessary. Raw states that, while not a specific remedy, they ought always to be used in cases of a virulent type. A *synthetic drug*, ethylhydrocuprein or optochin, with supposedly a specific bactericidal action on the pneumococcus has been widely used in the past few years with extremely good results, if employed early in the course of the infection. According to Moore and Chesney an initial dose of 0.15 gm. is given and 0.15 gm. every two and one-half hours afterward until 1.5 gm. are given. The dosage is given daily until symptoms abate or toxic (eye) symptoms appear. Kolmer and Steinfield contend that the simultaneous administration of optochin greatly increases the pneumococcal activity of the antipneumococcus serum, while Moore and Chesney treated 75 cases without any noteworthy therapeutic benefit.

Prophylactic Inoculation.—Cecil and Austin³ vaccinated 12,519 soldiers at Camp Upton with a vaccine composed of 6,000,000,000 to 9,000,000,000 of Types I and II and 4,500,000,000 to 6,000,000,000 of Type III. From three to four doses were given at intervals of five to seven days. From the comparison of the incidence of pneumonia among the vaccinated men and a large number of controls Austin and Cecil conclude that very definite protection is given against pneumococcic infection of Types I, II, and III. The duration of this immunity has not as yet been determined. In still later work with a lipo vaccine Cecil and Vaughan⁴ vaccinated 13,460 men at Camp Wheeler. In the three months succeeding the injection the incidence of

¹ *Hand-book of Practical Treatment*, Phila., 1917, iv, 225.

² *Military Surg.*, 1918, xlii, 320.

³ *Jour. Exp. Med.*, 1918, xxxviii, 19.

⁴ *Ibid.*, 1919, xxix, 457.

LOCAL MEASURES.—When in doubt as to whether venesection should be employed or not, it must be remembered that early local bloodletting (cupping, leeching) is followed by relief from pain and dyspnea, but that these measures should be reserved only for robust persons. Counterirritation by means of sinapisms is useful at the onset, and if pains be severe, strapping the side affected gives much comfort. The cotton jacket has certain advantages in maintaining the free, local action of the skin. The *topical use of cold* in the form of ice-bags has been practised extensively by Lees of England and Mays of America with brilliant success. Other hydriatic measures suggested by Baruch, as cold compresses, wrung out of water at a temperature of 60° F. (15.5° C.), and applied to the anterior and posterior portions of the chest (the edges overlapping in the axilla), give similarly good results. They should be made of several thicknesses of muslin held together by basting, covered by flannel, and firmly secured by safety-pins. A reapplication every half-hour or hour is advised.

SECONDARY PNEUMONIA

Pathology.—The lesions are identical in character with those of primary lobar pneumonia, but the areas involved have not always the same regular distribution. Congestion surrounding the hepatized lung tissue is not infrequently extensive. We see, postmortem, a tendency to commingling with small areas of lobular pneumonia. Both the streptococcus and the *Micrococcus lanceolatus* are frequently found on microscopic examination.

Etiology.—Most instances are secondary to the acute infectious diseases, and it is probable that the specific causes of certain of the latter (Eberth's bacillus, Pfeiffer's bacillus, etc.) have the power to excite the morbid changes of acute lobar pneumonia. *Colon-pneumonia*, due to the *Bacillus coli*, is the result of hematogenous infection either from the intestinal or from the urogenital tract. In the majority of instances, however, in which this disease develops in the course of the acute infectious diseases the latter are to be regarded as merely furnishing an opportunity for infection by the *Micrococcus lanceolatus*.

Symptoms.—The rational symptoms are often absent. Close observation may, however, detect more or less dyspnea, cough, and increased fever, and rarely the attack is heralded by a rigor, followed by an exacerbation of fever, the pneumonic type of breathing, pain, cough, and the characteristic expectoration.

The **physical signs**, when carefully observed, usually serve to enlighten the physician as to the nature of the affection. Hence it is a natural corollary that repeated physical examination is demanded in all cases in which there is danger of intervening lobar pneumonia.

Diagnosis.—This rests chiefly upon the physical signs, which are the same as in primary lobar pneumonia. Obviously, when the local subjective symptoms and the characteristic sputa are present a correct diagnosis is easily made. The fact must be emphasized that bronchopneumonia arises in the course of infectious diseases far more frequently than does lobar pneumonia.

Prognosis.—The occurrence of lobar pneumonia as an intercurrent affection adds greatly to the gravity of the primary disease. It is especially dangerous when it appears as a sequel during convalescence from acute infectious diseases.

The **treatment** is similar to that of primary lobar pneumonia, though less satisfactory in its results.

BRONCHOPNEUMONIA

(*Capillary Bronchitis; Catarrhal Pneumonia*)

Definition.—An inflammation of the minute bronchi and air-vesicles due either to the extension of inflammation from the capillary bronchi to the air-vesicles or to an inflammatory process set up in atelectatic lobules.

Pathology.—*Macroscopically*, the lungs present decided variations in persons who have died of bronchopneumonia. On the pleural surface may be noticed purplish or slaty patches, often sunken (atelectasis), intermingled with the more elevated patches of healthy lung and grayish consolidation, and smoother and more moist than croupous pneumonia. Similar appearances are presented by the cut surface. On pressure, fluid exudes—edematous from the healthier areas, and grayish and puriform from the consolidated areas. The small bronchi usually contain more or less mucopurulent material. Their walls are greatly thickened, and on section the cut surface presents a nodular appearance. Dilatation of the smaller bronchi may be observed, and minute consolidated areas, varying in size from that of a pin's head to that of a pea, may be seen surrounding the thickened walls of the bronchi. When they become confluent, large areas of lung tissue may become consolidated. The solidified zones are firm to the touch, being destitute of air, and at first they contain blood; hence their color is a dark red, later turning to a grayish hue. The condition is usually bilateral. As a rule the bronchial glands are swollen and inflamed. In the non-consolidated portions of the lung the air-cells are considerably dilated.

The essential lesion is a productive inflammation of the bronchi and of the immediately surrounding air-spaces with the formation of new tissue (Delafield). This form of inflammation may merge into sclerosis of the lung or chronic thickening of the pleura. *Microscopically*, the walls of the bronchioles and alveolar passages are seen swollen and infiltrated with cells; they likewise contain plugs of mucous exudate, most marked near the center of the process. The air-cells toward the periphery show much less exudate. The latter consists of serum, some mucus, and many swollen cells from the alveoli (soon showing fatty degeneration), leukocytes, and also red blood-cells in small numbers. Fibrin is seen in small quantity if at all.

In deglutition and aspiration pneumonia the leukocytes are present in much larger numbers, and the exudate tends to suppuration, while in the hemorrhagic forms the red blood-cells are relatively increased.

Among the associated lesions to be mentioned are: (a) Catarrhal inflammation of the mucous membrane of the bronchi, and (b) exudative inflammation of the air-cells, which become filled with epithelium, fibrin, and pus, with resulting consolidation of the lung. (c) The pulmonary pleura is often coated with fibrin, but less regularly than in croupous pneumonia.

Etiology.—(1) A marked predisposing influence is *age*, the disease being most prevalent among young children. In them it may appear in association with measles, whooping-cough, scarlet fever, and diphtheria, but not infrequently it is entirely independent of these diseases. Infants are especially susceptible to the affection, most instances of pneumonia at this period of life being of the lobular form. Other conditions that act as predisposing factors in children are improper exposure to cold, unsanitary surroundings, rickets, and chronic diarrhea. Bronchopneumonia is also frequent in the aged, often being occasioned by certain debilitating causes and chronic diseases that are common to advancing years (emphysema, gout, chronic valvulitis).

(2) *Season.*—The affection prevails especially in the winter and spring months; particularly is this the case in those forms that are unassociated with the acute infectious group of diseases.

(3) It also supervenes as a complication in such acute infectious diseases as influenza, typhoid fever, erysipelas, and small-pox, and is of serious import. According to my own observations, it is more commonly met with in the diseases above mentioned than lobar pneumonia.

(4) The *inhalation of food particles and other substances* often serves to convey the agents of inflammation to the lobules of the lungs. A long-continued recumbent posture predisposes the patient to bronchopneumonia. It is, however, in conditions in which the larynx and bronchi have totally or in part lost their sensitiveness—as in coma due to apoplexy, uremia, and allied cerebral states—that retention of bronchial secretions occurs, and that, owing to gravitation, these secretions reach the minute bronchi. *Inhalation pneumonia* may follow operations upon the nose, mouth, larynx (tracheotomy particularly), and is often secondary to carcinoma of the larynx and esophagus. It is also the pneumonia of newborn children.

(5) It must not be forgotten that quite commonly bronchopneumonia is caused by the *tubercle bacillus* (*vide* Pulmonary Tuberculosis).

Bacteriology.—Weichselbaum has shown the presence of streptococci with the greatest frequency in the usual, secondary form. The pneumococcus is often found, and in a goodly number of cases the *Staphylococcus aureus* (Neumann), while in influenza the specific organism may itself cause bronchopneumonia (Pfeiffer). Chickering and Park¹ believe that the particular *Staphylococcus aureus* found in the influenza outbreak at Camp Jackson caused bronchopneumonia of a virulent type, exhibiting the cherry-red, indigo-blue color due to a type of cyanosis. This is the same organism found in the mouth secretions of healthy persons. Numerous other organisms have been found (typhoid bacillus, *Bacillus coli communis*). Mixed infection with the *Diplococcus pneumoniae* is almost the rule when lobular pneumonia is secondary to the acute infections. A. Graeme Mitchell states that Type IV is the most frequent infecting organism in bronchopneumonia during childhood. In 90 cases all the severe complications (empyema, meningitis) were in those infected with the Type IV pneumococcus.

Symptoms.—Two clinical forms may be distinguished:

(a) **Primary bronchopneumonia**, which occurs in 30 to 35 per cent. of all cases, is met with generally in children, and presents, in great part, the symptoms of an acute bronchitis of severe grade (*cough, dyspnea, pain, fever*). When occurring in weakly subjects the onset may be gradual. The cough is attended with *expectoration* (glairy and tenacious) that may be blood-tinged, in the form of droplets or points. The fever is moderate, the temperature ranging from 101° to 104° F. (38.3°–40° C.), and is of irregular type; in severe cases, however, continued high temperature may occur. Physical examination gives the same result as in the secondary form. The *duration* is from two to four weeks, the fever terminating by *lysis*. West holds that primary bronchopneumonia in children is of pneumococcic origin.

(b) **Secondary bronchopneumonia** is the variety usually met with. The symptoms are frequently veiled by those of the primary affection, and, indeed, a moderate grade of lobular pneumonia is frequently unsuspected during life when arising in the course of other grave diseases.

It is usually preceded by bronchitis affecting the larger bronchi, and in this common event the first symptom that directs attention to the disease is the *sudden increase* in the frequency of the *respirations*, which rise as high as 60 or even 80 per minute. An initial chill is rare. *Fever* develops suddenly or, if previously present, increases rapidly. An early symptom is the *cough*, which is usually hard, harassing, frequently painful, and accompanied by *expectoration*. The *pulse* is frequent, and in the later stages may be quite

¹ *Jour. Amer. Med. Assoc.*, 1919, lxxii, 617.

rapid, feeble, and irregular. The type of the fever is similar to that of the primary form.

Blood.—There is usually marked leukocytosis of the polynuclear type. Absence of leukocytic increase is of serious meaning, implying lack of resistance. On the other hand, a high leukocyte count does not necessarily indicate a favorable prognosis, but a good reaction. Wilson¹ has obtained streptococci from blood-cultures and from the feces in large numbers.

Physical Signs.—At the beginning of the attack the only sign is the presence of subcrepitant and sibilant râles, pointing to general bronchitis. Shortly, larger or smaller areas of consolidation become manifest. At first rapid breathing, and soon cyanosis, affecting first the lips and conjunctivæ, may be observed; later, the face becomes dusky and the finger-tips blue. *Palpation* shows defective expansion and increased tactile fremitus over the consolidated areas. The *percussion-note* is dull or, less frequently, hyperresonant if the area be small. *Auscultation* reveals numerous fine, subcrepitant râles, corresponding to the consolidated portions. The respiratory murmur may be bronchial, though more often bronchovesicular. The signs are usually noted in both lungs. Confluence of the numerous small, consolidated areas may result in large fields of dulness and true bronchial breathing. In cases of extensive consolidation there may be inspiratory retraction of the lower sternum and lower ribs, indicative of deficient lung expansion (Butler). Diemer, during an epidemic of bronchopneumonia at Camp Lewis, reports on 23,000 draftees fluoroscopically studied, of which 7000 were influenza patients. Bronchopneumonia was found in some 2200 cases. The results were definite and often suggested bronchopneumonia before clinical findings were obtained.

Duration.—(1) In children this varies in different cases. Rarely do fatal instances last more than two or three weeks, while they may be as brief as two or three days. On the other hand, cases in which recovery ensues frequently last from six to eight weeks, though rarely from one to three weeks only. Two special forms demand brief description:

(a) The *cerebral*, in which restlessness, convulsions, and delirium become so marked as to overshadow entirely the pulmonary symptoms. Not infrequently the onset is characterized by convulsions, high fever, prostration, and alternating stupor and delirium. After the lapse of from two to five days pulmonary symptoms appear, while the cerebral decline.

(b) Other cases may manifest a *subacute onset*, in which there is anorexia and occasional vomiting, with the nervous symptoms before noted.

(2) The *protracted forms* are those in which (a) the symptoms of acute bronchopneumonia give place to those of a similar though chronic state. The general disturbances may not be marked in some instances, but usually there are cough, loss of appetite, or inability to gain in flesh and strength, and the signs of consolidation persist; (b) those presenting fever of an irregular type, together with decided prostration, in addition to the symptoms of the preceding variety. In many cases belonging to this form the lesions are tuberculous.

In adolescence the cerebral symptoms are not as well marked as in children. Two anomalous varieties are met with in practice:

General Bronchopneumonia.—The attack develops suddenly and is severe. There are chills, high fever, marked prostration, headache, chest and loin pains, a rapid pulse (soon becoming feeble), rapid and labored respirations, cyanosis, restlessness, delirium, and cough that is at first dry, and followed by mucopurulent, blood-tinged sputum.

The *physical signs* are defective expansion and an increased tactile fremitus.

¹ *War Med.*, Paris, 1918, ii, 556.

The percussion-note may be either normal, tympanitic, or dull; the auscultatory signs are large moist, subcrepitant, crepitant, sibilant, and sonorous râles over both lungs, and a harsh or bronchovesicular respiratory murmur. The affection is very grave.

Resembling Tuberculous Bronchopneumonia.—The symptoms appear slowly, and the case pursues an insidious course. Cough, catarrhal expectoration, moderate fever (hectic type), and night-sweats are noted.

Physical examination discloses generalized bronchitis coupled with circumscribed areas of consolidation. Resolution may take place at the end of eight or ten weeks, and complete recovery ensue; when, however, this favorable event does not occur, the case drags on for an indefinite period, and finally ends fatally. There are no tubercle bacilli in the sputum.

Diagnosis.—This can be arrived at by considering—

(a) The nature of the antecedent affections and their etiologic circumstances;

(b) The distribution of the consolidated areas in both lungs;

(c) The fact that the physical signs of consolidation are subsidiary to those of generalized bronchitis;

(d) The intense dyspnea and cyanosis;

(e) The type of the fever, irregular as a rule, and its gradual decline;

(f) The frequently long duration.

Differential Diagnosis.—Doubtless, *lobar pneumonia* is constantly mistaken for bronchopneumonia, and particularly when, in the latter disease, a large portion of one or both lungs becomes inflamed in consequence of the coalescence of small foci of consolidation. The points of distinction may be tabulated as follows:

BRONCHOPNEUMONIA	LOBAR PNEUMONIA
<i>Etiology</i>	
Presence of various pathogenic organisms. Usually secondary to bronchitis and acute infectious diseases (e. g., measles, whooping-cough).	Presence of the <i>Diplococcus pneumoniae</i> . Usually a primary disease.
<i>Clinical History</i>	
Onset gradual, without rigor. Fever is, in proportion to the extent of inflammation, of irregular type, and declines by lysis after a variable duration. Sputum glairy, tenacious, and in adults may be blood-tinged. Dyspnea and evidence of carbon-dioxid poisoning prominent. Herpes labialis absent. Physical signs of generalized bronchitis always marked, and usually preponderating over those of consolidation. Consolidation commonly bilateral. Duration indefinite, often extending over many weeks. Consolidated areas liable to become the seat of tuberculous infection.	Onset abrupt, with rigor; previous health generally good. Fever is high, of continued type, and falls between the fifth and ninth days by crisis. Sputum characteristic (rusty or prune-juice). Dyspnea and cyanosis relatively less marked; anxious countenance. Herpes labialis commonly present. Signs of bronchitis generally absent, those of lobar consolidation always preponderating. Commonly unilateral. Duration definite as a rule, convalescence following crisis. Far less likely to become the seat of tuberculous infection.

It may be difficult to distinguish *tuberculous bronchopneumonia* from the disease under consideration. Indeed, a non-tuberculous bronchopneumonia may be located at the apex of the lung. The differentiation is to be based upon the presence or absence of the signs of softening, and upon a microscopic

tion and inspiration lobular pneumonia, especially when occurring after operations upon the larynx or trachea, are frequently fatal. The mortality rate in this disease varies from 25 to 50 per cent. In primary bronchopneumonia, however, the mortality is decidedly lower.

Treatment.—Prophylaxis.—There are few diseases that can be so effectually prevented as can bronchopneumonia. In the first place, proper attention to the mouth as well as to the position of the patient (which should be changed frequently) during attacks of acute infectious diseases will prevent its development in a great proportion of this large class of cases. Adequate protection against exposure during convalescence from measles, whooping-cough, etc., is also a potent factor in preventing the disease, as is the timely handling of catarrhal affections of the nose, pharynx, larynx, and larger bronchi.

Treatment of the Attack.—Certain *sanitary arrangements* are of the utmost practical importance. The sick room should be well ventilated and its atmosphere kept at a uniform temperature—68° to 70° F. (20°–21° C.). The air of the room should also be well laden with moisture, which may be generated from a croup-kettle or other suitable vessel.

General Measures.—High fever calls for tub-baths, the temperature of the water at first being set at 95° F. (35° C.), and then gradually cooled to 75° or 80° F. (23.8°–26.6° C.). The gradually cooled bath or the cold pack may be used two or three times daily. The effects are to reduce temperature, to promote refreshing sleep, and to improve the character of the respiration. This mode of treatment is especially effective in cases that begin abruptly. In cases presenting moderate pyrexia, cold spongings, combined with the use of the ice-bag to the head, may suffice. The following fever-mixture may be employed for a child five years old, though it is not to be regarded as a substitute for hydrotherapy, but is merely supplemental to the latter:

R.	Potassii citratis,	3iiss (10.0);
	Spir. ammonii arom.,	f3ij (8.0);
	Spir. ætheris nitrosi,	f3iv (15.0);
	Glycerini,	f3j (4.0);
	Liq. ammon. acet.,	q. s. ad f3iv (120.0)—M.

Sig. Teaspoonful in water every two hours.

In *children* a mild mercurial purge at the outset is advantageous, and subsequently by the use of salines or glycerin suppositories a daily evacuation of the bowels is to be secured.

The Diet.—The bodily strength is to be maintained by careful, methodical feeding, milk, eggs, albumin, and broths being the best forms of food. The milk should be predigested if there be marked pyrexia, and egg-white may be given in cold water or as egg-lemonade. The cough is often wellnigh constant and very distressing. Frequently the use of remedies that promote secretion, combined with a small dose of opium, will, under these circumstances, afford relief. A useful formula for a child from three to five years old is the following:

R.	Tinct. opii camph.,	
	Spir. ætheris nit.,	āā f3iiss (10.0);
	Liq. ammonii acet.,	q. s. ad f3ij (60.0).—M.

Sig. Teaspoonful in water every two hours.

Dover's powder is also of value in relieving the cough. When the expulsion of the sputum is attended with great difficulty the preparations of ammonium often meet the indications. Of these the chlorid is the most effective, but,

unfortunately, this is often objected to, and we must then rely upon the carbonate or the aromatic spirits. The bronchi may contain an abundance of secretion that cannot be expelled, despite the use of the above measures. Under these circumstances an emetic may be given composed of the wine of ipecac (3j—4.0), combined with alum (gr. xx to xxx—1.3–2.0), and administered to a child every ten or fifteen minutes until emesis occurs. Oxygen by inhalation is to be used early and persistently to overcome the cyanosis.

Cardiac stimulants are required if the pulse fails, with increasing cyanosis. The preparations of ammonium owe much of their reputation in this disease to their stimulating properties. These agents when boldly used may suffice to re-establish the cardiopulmonary circulation. Sudden heart exhaustion may occur, associated with mucous râles in the larger bronchi and rapidly developing cyanosis; atropin (dose, gr. $\frac{1}{80}$ to $\frac{1}{40}$ —0.0001–0.0012 gm. every second or third hour) tends to arrest this mucous secretion. Alternating douching with hot and cold water and electricity should be given a trial. Injections of salt solution increase arterial tension and act as a “whip” to all emunctories, aiding in the elimination of toxins. They should be used in serious cases. In streptococcic bronchopneumonia antistreptococcus serum may be tried.

STREPTOCOCCIC (HEMOLYTIC) PNEUMONIA

During the fall of 1917 and the early part of 1918 there arose in cantonments and camps of this country an epidemic of pneumonia of severe proportions coincident with and following an epidemic of measles among the recruits. The epidemic of pneumonia was more severe among the troops from the South and the suburban population, whereas the troops from the northeastern sections of the country, representing men, for the most part, from the urban centers, were relatively slightly affected. The epidemic attained its greatest height at Camps Pike, Wheeler, and Beauregard, while Camps Devens, Upton, and Meade were at no time seriously involved. In the first three camps the death-rate was 24 or over (Russell). In the camps in which the men came from the northern section of the country the death-rate was under 8. At Camp Pike the incidence of pneumonia to the total number of men in the cantonment in December, 1917, at the height of the epidemic, was 1.10 per cent. The mortality rate was extremely high, in some camps being over 50 per cent.

The pneumonia, on account of the wide differences from ordinary lobar or bronchopneumonia, was soon recognized as a peculiar type, and led to extensive studies everywhere. The most intensive studies were carried out by the commission appointed by Surgeon-general Gorgas, headed by W. G. MacCallum and Rufus Cole. A large part of the knowledge we have gained of this type of pneumonia is the result of the work accomplished by this commission.

Etiology.—The *Streptococcus hemolyticus* has been shown to be the causative agent of this type of pneumonia. This organism was isolated from the sputum, from the blood, and from the tissues after death of those suffering with streptococcic pneumonia. Throat cultures made from the men in the measles wards at the various cantonments showed the presence of hemolyzing streptococci in the throats of large numbers of the men. Cultures made before their entrance to the measles wards were usually negative, showing that the infection probably arose during the course of the measles in the ward. Cole is of the opinion that infection, once started in a ward, is followed by wide

dissemination of the organisms, which become extremely virulent through repeated passage from one to another person. The organism seems to do harm largely through its local action upon the respiratory tract, with no tendency to spread through the body as a septicemia, and it seems to be relatively innocuous unless there be some pre-existing inflammatory lesion present in the upper air passages, as occurs in measles, acute bronchitis, etc.

Pathology.—According to MacCallum, infection with hemolytic streptococci may produce a patchy, lobular pneumonia, or the more characteristic pathologic change which he has termed *interstitial pneumonia*. This latter condition is characterized by the inflammatory changes occurring primarily around bronchioles and in their wall, subsequently spreading to the alveolar tissue. In addition to the pulmonary changes there is a universal tendency to a pleural exudation. This exudate may form adhesions so strong that, as I have seen it, it becomes almost impossible at times to remove the lung from the thoracic cavity without extensive lacerations of the parietal pleura and the visceral pleura and lung. Probably the most characteristic finding is a purulent effusion, the pus being loose in the pleural cavity or walled off by adhesions into numerous pockets. An ulcerative laryngitis is very frequently observed, while suppurative pericarditis is also seen at times.

Clinical History.—Hemolytic streptococcic pneumonia occurred after measles in the majority of cases, though many relatively mild epidemics took place in which measles played little part. It may develop during the measles attack, but more characteristically appears days or even from one to three weeks after the primary disease. Although the usual signs of measles may disappear, a hoarseness, cough, and expectoration persist. Insidiously the cough increases, temperature appears, and there is some difficulty in breathing. When admitted to the ward the patient does not appear very ill, but gradually the symptoms increase. The *fever* may go up to 104° F., and is usually irregular; with the appearance of pus the temperature becomes markedly remittent or intermittent. The *pulse* is not particularly rapid at any time. *Respirations* are not unduly rapid, but the patient suffers from extreme respiratory distress. The difficulty lies with inspiration, so that even early in the disease the patient may be seen calling on all his accessory muscles of respiration to aid him in his difficult breathing. The *cough* is persistent, severe, and often painful. The *sputum* is fairly free and expectorated with comparative ease. It is not typical; at times it is nummular, mucopurulent, or mucoid; again, it may be extremely purulent and greenish in color. *Pain* is usually always complained of during the course of the disease, and it is a typical pleurisy pain. The patient usually does not become delirious until shortly before death, but he is restless and anxious during the greater part of the disease.

Physical Examination.—The patient lies in bed, extremely cyanotic, and breathing with great difficulty. On examination of the lungs a great variety of physical signs may be elicited. Here and there throughout the chest may be detected areas of impaired resonance, notably at the bases, and over these areas the breath sounds may be harsh or even tubular. These areas change from time to time, and rarely do the signs show a frank consolidation of a large part of the lung. Râles are heard over the entire chest, frequently by their loudness obscuring entirely the character of the breath sounds. Râles of every description may be heard, and they vary from hour to hour in their location.

Diagnosis.—This depends upon the history of the case, the occurrence of an irregular or atypical bronchopneumonia, and the finding of the causative organisms in the coughed-up sputum. In the diagnosis the greatest importance lies in the early and prompt recognition of pus. Marked variations in

sections of this country. During the early part of 1901, and again in the winter of 1902-03, pandemic visitations of the disease occurred in the United States. It is probable that the disease is a type of toxemic shock.

The last pandemic originated in Spain (hence called Spanish influenza) in the spring of 1918 and moved westward along the lines of travel, rapidly spreading over nearly all Europe, including Germany, Italy, France, England, attacking from 20 to 40 per cent. of the population. It reached the United States August 28th and spread rapidly in the First Naval District and later all over the United States. In Philadelphia during the month of October the disease was more fatal than anywhere else in the United States. During one week of this month the death-rate reached the enormous figure of 159 per 1000.

Pathology.—There are no special anatomic lesions that characterize the disease. In the rare instances in which death occurs in uncomplicated cases the catarrhal changes of the respiratory and gastro-intestinal mucosa disappear after death. In the abdominal type of the affection there may be enlargement of the glands of Peyer and of the solitary follicles. Among the fatal complications are pneumonia (either lobular or lobar), serofibrinous pleurisy, empyema, purulent pericarditis, nephritis, and rarely cerebrospinal meningitis and acute hemorrhagic encephalitis. All of these, however, may be of influenzal origin. The typical lung texture changes are those of bronchopneumonia (often confluent, involving one or more lobes without fibrinous exudation, in 1918), and in the centers of the involved lobules grayish-yellow pinhead to pea-sized, slightly elevated foci may be seen and from which a thick, greenish-yellow pus may exude on section. Acute pulmonary emphysema with consequent venous stasis accounting for the cyanosis is a common finding (Torrey and Grosh). Lord invites attention to an increase of fibrous connective tissue leading to pulmonary induration in protracted cases. The myocardium seems to be unaffected throughout the course of influenza and its complicating pneumonias (Cowie and Beaven). Eichhorst found anatomic evidence of injury of the heart in 0.3 per cent. of 2411 cases. The report of Lucke¹ and his associates is an extremely detailed and complete summary of the findings at post-mortem of 125 cases of influenza seen during the recent pandemic.

Etiology.—**Bacteriology.**—Early in the year 1892 Pfeiffer discovered the *influenza bacillus*. When stained by the aid of gentle heat with Ziehl's carbol-fuchsin, 1 part; water, 9 parts, or Löffler's methylene-blue, it may be observed as a small dumb-bell, having knotted ends connected by a rod-like shaft. It is a Gram-negative bacilli and grows best when mixed in culture with other organisms. These bacilli are obtained from the sputum and nasal secretions. They have also been found in the blood and other tissues. This bacillus can be cultivated only in media containing hemoglobin, and when inoculated into rabbits it causes symptoms resembling those of influenza. Although *B. influenzae* is recovered in practically all cases of influenza, there is great doubt in the minds of many investigators of the pathogenicity of these organisms. The literature on this phase of the disease is voluminous. Bacteriologists, immunologists, and public health officials are all of varying opinion as to the rôle this organism plays in the etiology of the conditions. The most conclusive evidence that has been brought forth implicating this organism is that of Blake and Cecil,² who produced a respiratory infection in monkeys akin to influenza by the injection of *B. influenzae* into the nose and intratracheally. However, the British Medical Research Committee has concluded that we do not as yet understand the nature of the condition known as epidemic influenza,

¹ *Arch. Int. Med.*, 1919, xxiv, 154.

² *Jour. Amer. Med. Assoc.*, 1920, lxxiv, 170.

and Park¹ believes that there is no proof that any one germ is present in all cases. The frequency with which *B. influenzae* may be isolated in clinical cases of influenza is shown by the figures of Pritchett and Stillman, who cultivated the Pfeiffer bacillus from the mouth of 93 per cent. of cases of influenza and bronchopneumonia. Other organisms that may be recovered are: *Streptococcus viridans*, *Streptococcus hemolyticus*, and the *Micrococcus catarrhalis*.

Modes of Conveyance.—Pepper suggested that the micro-organism may be most universally distributed, and that under certain extraordinary atmospheric or telluric conditions it acquires a degree of virulence that renders all subject to its attack. Influenza is communicable by contagion, but there is slight evidence to show that it may be transferred by fomites. The disease showed an extraordinary degree of contagiousness during the 1918 epidemic. It is during the period of coryza and bronchial cough that the disease is most contagious, "being transmitted almost entirely by direct contact, and by infection within a radius of a few feet" (Keegan). Influenza is a common secondary infection, especially in childhood, and may occur in measles, diphtheria, scarlet fever, and other infections. In some epidemics the disease travels slowly, but probably always follows the lines of ordinary human and commercial intercourse.

Manner of Invasion.—The contagion probably enters the system with the inspired air through the respiratory tract. Some contend that the infection atrium is the alimentary canal. Rosenau² tried almost every possible way of transmitting the disease to a group of volunteers, but was totally unsuccessful.

Predisposing Causes.—All persons are liable to the contagion. Age has slight influence, the period of greatest susceptibility being from the twentieth to the thirtieth year. The very young are least susceptible, and during an epidemic are apt to be affected last, while old persons are frequent sufferers. Subjects whose vitality is lowered by neuropathic heredity, exposure and fatigue, or chronic maladies are among the first to suffer during an epidemic. Of 125 independent epidemics, 50 began in the winter months (Hirsch), but the disease runs its course equally through all seasons. During the recent pandemic pneumonia was a complication in about one-half the pregnant women who had the disease (J. W. Harris).

Immunity.—A primary attack of influenza confers a brief period of immunity in most instances, although relapses occur in 10 per cent. of the cases (Turney). Many persons suffer from the disease with the reappearance of fresh epidemics, so that two, three, four, or even more attacks may be observed in the same individual (recurrences). Epidemic influenza increases susceptibility to pneumonia and probably also to typhoid fever.

Clinical History.—General Symptomatology and Course.—The incubation period is quite brief, rarely exceeding two or three days. The onset is generally sudden, with either a severe rigor or repeated slight shiverings, accompanied by a rapid elevation of temperature which may touch 104° or 105° F. (40.5° C.). intense headache, distressing myalgic pains, and great prostration. The primary fever, however, fluctuates greatly, as does also the severity of the symptoms, both local and general. Profound prostration characterizes the vast majority of instances during the invasion period. The fever usually begins on the second or third day, and may, though rarely, continue normal, with recovery. More commonly, however, there is a secondary rise following the remission, accompanied by a coryza and bronchitis. Depression of spirits, restlessness, insomnia (more rarely undue somnolence), and frequently delirium are among the prominent nervous phenomena.

¹ *Jour. Amer. Med. Assoc.*, 1919, lxxiii, p. 318.

² *Ibid.*, p. 311.

Rare Modes of Invasion.—The infection may set in (a) by vertigo, (b) by apoplectic features, (c) by bilious vomiting, (d) by an abrupt and profound prostration. Nosebleed sometimes occurs.

The most striking symptom is pain, which in many cases is referable chiefly to the forehead, temples, occiput, eyeballs, and root of the nose. General neuromuscular pains are often present. The principal seat of the pain is commonly the lumbar spine (rachialgia). I have frequently noted cutaneous hyperesthesia. The pains may take the form of neuralgia of individual nerves or of pleurodynic stitches, or there are localized areas of burning, boring muscular pain. The temperature may, as before intimated, mount quite high at the beginning, and if so it usually remits during the first night. It subsequently pursues a comparatively low range. The temperature-curve is markedly irregular, and often terminates by an apparent crisis. The pulse is small, feeble, running, irregular, and even intermittent, and I have sometimes observed it to be unusually slow. The depressive effects of the poison upon the heart often reach a dangerous degree. No leukocytosis is present as a rule. An occasional mild leukocytosis (10,000 to 15,000), however, is noted in uncomplicated cases. In the recent pandemic leukopenia was noted and proved to be an aid in differential diagnosis. In many cases *dyspnea* is a rather conspicuous symptom, occurring independently of pulmonary complications. The same is true of cyanosis. In the outbreak of 1918 there was frequently observed a deep blueness suggestive of methemoglobinemia. Sweating may be troublesome.

Clinical Types.—Different types have been described based on the differences in the local manifestations and the varying degrees of toxemia. Influenza is remarkably protean in its features, and the enumerated types quickly and frequently merge into one another. (a) *Respiratory Type*.—Local catarrhal symptoms usually develop in the course of one or two days. They are, as a rule, evidenced first by a suffusion of the conjunctiva, with excessive lachrimation, frequent sneezing, and slight pharyngitis. A little later, in most instances, hoarseness and cough come on, the latter being hard, racking, paroxysmal in character, and resembling whooping-cough. The cough and other local symptoms are due to an intense, dry, laryngotracheal irritation. In most instances the expectoration is scanty, and in these the physical signs are very generally negative. In a smaller proportion of the cases there is considerable expectoration, and the physical signs of ordinary bronchitis are manifested. (b) *Gastro-intestinal Type*.—The catarrhal symptoms may center in the digestive system, most frequently in children. In such, vomiting comes on early and is apt to be repeated at longer or shorter intervals. There is diarrhea, more or less urgent, with sharp abdominal pain, as a rule. (c) The *cardiac* group of symptoms that occasionally supervenes comprises heart failure and distress, with a rapid, feeble pulse (a toxic form). (d) The *nervous* or *typhoid* (toxic) *type* presents a continued fever, with the signs of the typhoid state. Two classes of nervous symptoms are seen—"comatose and delirious" (Bury). Patients may be seized with intense headache, or an epileptic or apoplectic fit, or there may be local paralysis or hemiplegia. Muscular rigidity, especially of the neck, is far from uncommon. (e) The *rheumatoid type* manifests itself by violent pains in the muscles all over the body. There is no visible change in either the joints or the nerve-trunks. (f) Huchard calls attention to *apyretic forms*, in which there may be marked pulmonary congestion or actual lobar pneumonia without fever, without expectoration, and often without cough. (g) There are ambulatory forms which are important because they tend to spread the affection. (h) Franke describes a chronic form assuming the guise of catarrhal affections of the respiratory and gastro-intestinal passages. The raspberry tongue is characteristic of chronic influenza.

Leading Features and Complications.—(1) **Pulmonary.**—Severe bronchitis, particularly affecting the capillary tubes and leading to bronchopneumonia, is a common and very serious complication. In the pandemic of 1918 in from 10 to 15 per cent. of the cases a massive and often fatal bronchopneumonia caused primarily by the influenza bacillus developed. Leukocytosis was absent as a rule. On the other hand, Keeton and Cushman found the range of leukocytosis to lie between 15,000 and 20,000 in bronchopneumonia. In those recovering, the blood count shows a very transient period of leukopenia; in those dying, a more marked and persistent leukopenia. As a secondary result we are apt to observe the development of collateral pulmonary edema, with its usual fatal termination; and while this complication is prone to develop in the so-called thoracic type of influenza, it is by no means limited to this class of cases. I have observed bronchopneumonia in cases in which the physical signs of bronchitis were not presented prior to its onset. It may originate apparently in the profound prostration of the nervous system—a condition which also annuls in great part the phagocytic action of the leukocytes. The objective signs may be limited to persistent râles at one or more places (Lord). In the pandemic just passed it was common to meet suppressed breath sounds with fine râles in the infrascapular and lower auxiliary regions in the absence of other physical signs.

The chief clinical features of influenzal pneumonia, as it occurred in 1918 and as compiled from Army reports largely, have been well summarized by Lewis Conner: In the first place these were exceedingly varied on account of the extraordinary variety of pathologic lesions and the multiplicity of types of infecting organisms. The onset was either gradual during the course of the influenza, the pulmonary signs and symptoms making their appearance, or else it came on several days after convalescence was established, or appeared as a pneumonia from the start. The temperature, as contrasted with ordinary lobar pneumonia, was more gradual in onset, lower in range, a greater tendency toward remissions, and a slower fall to normal. The pulse-rate was often slow except in unfavorable cases. The same may be said of the respiration rate. Cough while frequently distressing, as a rule was not severe. Pain in the side was generally absent, as was pain elsewhere. The sputum was extraordinarily varied; usually more profuse and watery than in primary pneumonia; it was at times also rusty, blood-tinged, or frankly hemorrhagic. In the fulminating cases with early edema the sputum was poured forth in large quantities. Cyanosis was usually marked and without subjective distress or air hunger. Stupor and delirium, the latter either wild and active or low muttering in character, were common in severe cases. "The physical signs of the chest were distinguished by their late appearance, their wide distribution, their indistinctness, their slow disappearance, and the infrequency of the signs of frank consolidation. The signs were almost always bilateral."

Congestion associated with edema of the lungs occurs as a complication of influenza. Enlargement of the bronchial glands may also be noted, and the recognition of this condition may be aided by percussion over the upper four dorsal vertebræ, where dulness will be obtained.

Plastic pleurisy is commonly an associated condition, especially in cases of lobular or lobar pneumonia. Other forms of pleurisy also occur, though less frequently (serofibrinous and empyema). *Gangrene* and *abscess* of the lungs may arise as terminal complications.

Cardiac Complications.—Heart failure often manifests itself, and may prove fatal, though rarely. Purulent pericarditis is a rare complication, and is often secondary to pleurisy or pneumonia, while attacks of angina, which

nance, stationary subcrepitant râles). The general features also present dissimilarities. Thus the nervous depression and the myalgic and neuralgic pains are more marked in influenza, while the pulse-respiration ratio is less disturbed than in pneumonia.

(d) **Cerebrospinal meningitis** may manifest features that are almost identical with those characteristic of influenza. Thus during certain epidemics "grippe" patients may be stricken as by a blow: they suffer from intense headache—occipital and frontal—rachialgia, fever, prostration, delirium, and stiffness of the muscles, with slight retraction of the head. There may be convulsions and vomiting at the outset. Here the history with reference to the character of the prevailing epidemic and the attendant circumstances must be carefully considered, but an absolute diagnosis is sometimes impossible unless a laboratory investigation of the discharges or lumbar puncture be made.

(e) **Small-pox** in the pre-eruptive stage may be confounded with influenza, but the latter is soon diagnosticated by quick response to therapy and sweating, relieving the symptoms in twenty-four to thirty-six hours, whereas small-pox is resistant to all treatment, the appearance of the rash only bringing amelioration of the symptoms.

(f) This disease may be characterized by a paroxysmal cough, "which is so like the paroxysms of *pertussis* that at times the two are indistinguishable" (Holt).

Sequelæ.—Among the sequelæ are phthisis, chronic bronchitis, abscess and gangrene of the lungs (rarely), empyema (due to hemolytic streptococcus infection—Ballin), tachycardia, and angina pectoris. Chronic gastro-intestinal catarrh, chronic nephritis, and, less frequently, cystitis may also be mentioned. Latent forms of tuberculosis and chronic nephritis are often kindled into active and progressive affections by intercurrent influenza.

Among *nervous* sequelæ, which are both numerous and important, are to be noted especially insomnia, neuralgia, migraine, melancholia with tendency to self-murder, meningitis, acute ascending myelitis, peripheral neuritis, and perineuritis. The organs of special sense manifest a great variety of sequelæ, such as otitis media, otitis interna, mastoid abscess, conjunctivitis, keratitis, iritis, iridochoroiditis, acute glaucoma, etc. Menninger studied 100 cases of mental diseases associated with influenza in the recent pandemic and found the disturbances readily classifiable into four groups: delirium, dementia præcox (the largest group), other psychoses, and unclassified.

The **prognosis** is, on the whole, good in the sporadic cases. During a severe epidemic the mortality becomes appalling. In Philadelphia during the pandemic of 1918 in forty-five days 48,131 cases were reported, of which 12,687 (26.5 per cent.) terminated fatally. In the United States as a whole approximately 300,000 people are estimated to have died of influenza. Nor did the fatalities occur largely among the chronically sick, the infirm, and the aged. On the contrary, it was the young healthy adult who felt the full force of the scourge; witness the 19,249 deaths in the army camps that occurred among the picked men of the country, men in the prime of life who had been shown by repeated physical examinations to be healthy and free from disease.

Almost all fatalities are due to complications, especially *pneumonia*, and, less frequently, pulmonary congestion and edema, pleurisy, pericarditis, and cerebrospinal meningitis. The pneumonia of influenza shows a relatively higher death-rate by 18.1 per cent. in the pregnant woman (Woolston and Conley). The comatose type is often fatal. The mortality rate from influenza and pneumonia bears a close relationship to the number of persons living under barrack conditions (Heiser).

The **duration** of the attack is brief, though subject to variations. In mild

we may combine with quinin some salicylate. Experience has taught the profession that potassium citrate, administered in 10-grain (0.65) doses every hour well diluted, is useful as an eliminant. *Sleeplessness* may demand hypnotics, such as barbital, opium, and trional. It is necessary to utter a warning against the free use of coal-tar products, since they induce heart failure.

The local catarrhal conditions (coryza, laryngobronchial irritation, true bronchitis, etc.) must be treated according to the special indications presented in individual cases. For the coryza, inunctions of animal fats over the forehead and bridge of the nose are grateful. A flannel cap may be worn if agreeable to the patient. Steam inhalations through the nares and mouth often act beneficially, both upon the coryza and laryngobronchial irritation. For the latter common condition the following formula will be found serviceable:

R. Codeinæ sulph., gr. iv (0.25);
 Ammonii chloridi, ʒv (20.0);
 Spir. juniperi co., q. s. ad. fʒiv (120.0).—M.
 Sig. One teaspoonful in water every two or three hours.

If this prescription fail to mitigate the cough, we may resort to morphin in small doses. The bronchitis may sometimes be controlled by the use of sodium benzoate, ʒij (gm. 8), in aq. menth. pip., ʒiv (gm. 16), of which a tablespoonful may be taken every two or three hours. In the later stages, particularly if bronchitis be associated with free secretions, the oil of eucalyptus (ʒiij to v—0.2–0.3), in capsule, every four hours, has in my experience proved useful, as has strychnin (gr. $\frac{51}{80}$ —0.002), combined with the extract of gentian (gr. j—0.065). Digitalizing patients often serves to avert secondary cardiac developments. MacKenzie meets the cardiac complications in the convalescent period by improving the health of the body through fresh air and judicious exercise in the open. Chest pains may be relieved by the use of turpentine stupes and sinapisms.

(c) **Severe Forms.**—The *general management* is similar to that recommended in cases of medium severity, except that freer stimulation is usually demanded. Symmers contends that the anatomic and histologic changes in the circulatory apparatus indicate the necessity for stimulation from the moment the diagnosis is made. The medicinal treatment must also be more active than in the previous form, and often is heroic. Torrey advises lumbar puncture as a therapeutic measure in the meningeal form of influenza. Should there be sudden cardiac failure, it must be promptly met by stimulants (strychnin, camphor, ether, digitalis, alcohol, ammonia) given hypodermically.

Massive doses of camphor, *e. g.*, gr. xx to xxx—1.3–2.0—in sterile oil administered hypodermically, has fully established its efficacy as a cardiac stimulant in desperate cases. If a marked cyanosis occurs, the use of oxygen by inhalation is advised. The method devised by Meltzer, or that of Dr. F. Tice, injection of oxygen under the skin, may be employed. The various inflammatory complications must be treated as under other circumstances.

Specific Therapy.—“No data are available as to the effect of vaccines as a preventive or therapeutic measure in true epidemic influenza” (Park). The influenza bacilli have been incorporated in the mixed vaccines that have been put on the market for the treatment of acute upper respiratory infection. The value of these vaccines is extremely doubtful. Cowie and Beaven contend that an intravenous injection of typhoid protein (no more than 5,000,000 dead bacilli) may bring about a termination of the acute symptoms in from one to three days. Flexner¹ recommends the daily injection for three or four days

¹ *Jour. Amer. Med. Assoc.*, 1911, lvii, 16.

by means of lumbar puncture of the immune serum of the influenza bacillus in complicating meningitis. McGuire and Redden are convinced that the serum from convalescent pneumonia patients has a decided influence in shortening the course of the disease and lowering mortality. Sargent has suggested the transfusion of whole blood, citrated. Ross and Hund¹ advise early citrated immune total blood transfusion for the pneumonic complications of influenza. This method, however, necessitates the isolation of the infecting organisms of the donor and the recipient before definite results can reasonably be expected.

Injections of bacteria and foreign proteins for their effect in raising the leukocyte count and the opsonin and lysin content of the blood-serum, have been warmly recommended. Hermann, quoted by Roberts and Cary,² summarizes the subject as follows: "The intravenous injection of foreign protein serves as a stimulus for the liberation of specific antibodies in animals in which the previously injected antigen was unable to cause such a liberation."

The Convalescence.—The greatest injury to patients at this period comes from going out too early. Usually the temperature is subnormal for several days—a circumstance due to the weakness of the patient—and so long as this condition obtains the patient is highly susceptible to a chill. Hence it is a good rule not to allow exposure to the external atmosphere until the temperature has been normal for several days. The diet should now be more liberal, and tonics, such as gentian, iron, and quinin, may be administered and continued until complete restoration of the patient's health has taken place. In every way possible exposure to reinfection during the period of convalescence is to be avoided. The sequelæ must be treated according to general rules.

DENGUE

(*Break-bone Fever*)

Definition.—An acute infectious disease occurring epidemically in tropical and subtropical countries. Its chief symptoms are: a double febrile paroxysm (separated by an interval), arthritic and muscular pains, and a skin eruption in about one-half the cases.

Historic Note.—The disease was prevalent in Java as early as 1779, in India in 1824, and later in the West Indies, Spain, and in some of the southern American States. Mild epidemics have visited Philadelphia, New York, and Boston (during warm weather), but, as a rule, it has not traversed regions beyond 32° N. latitude.

Its *pathology* has not been studied, death being the rarest of events.

Etiology.—McLaughlin, of Texas, has isolated from the blood and cultivated a micrococcus. H. Graham has discovered an ameboid form resembling the *Plasmodium malariae*, but having a longer life-cycle.

Predisposing Factors.—Its prevalence is favored by the summer season, and to a slight extent by faulty hygienic conditions. On the other hand, age, race, sex, and social status are all without effect, most persons being susceptible, a fact that accounts for its marvelously rapid diffusion. As a rule, susceptibility is exhausted by one attack. The epidemics spread along lines of travel by land and sea. Graham's experiments in Beirut indicate that dengue is not contagious, but *Culex fatigans* may carry the infection from one person to another. Altitude is said to exercise an inhibitory influence.

¹ *Jour. Amer. Med. Assoc.*, March 1, 1919, p. 640.

² *Ibid.*, March 29, 1919, 922.

Clinical History.—There is a period of *incubation* that lasts from one to four days and exhibits no prodromes.

Invasion then is *abrupt*, with a slight chill; fever follows, the temperature reaching its maximum—103° to 106° F. (39.4°–41° C.) or over—at the end of the first or on the second day, and is accompanied by headache and by muscular and arthritic pains. The patient's sufferings are intense, the *pains* being described as "breaking"—a peculiarity to which the disease owes the popular name of *break-bone fever*. The painful *joints* are neither swollen nor tender, as a rule. Jones reports an epidemic in which severe pain was absent. The *respiration* and *pulse* are much quickened; there is anorexia and slight nausea. Febrile albuminuria is rare, delirium and mental torpor also; but *prostration* may become marked, and an *erythematous eruption* (*initial rash*) commonly appears. DeBrun noted the symptoms during the epidemic at Beirut (1892), and states that the eruption is roseolar, morbilliform, scarlatinous, or papular. He distinguished three groups of cases: 1. With high fever and marked associated symptoms, and with eruption. 2. Fever absent, the symptoms mild, with eruption. 3. The eruption the only symptom. The eruption may appear early, but has no fixed time, is evanescent in mild cases, and is never constant in character. It is attended with burning and itching, and DeBrun noted desquamation. *Hemorrhages* from the various organs (nose, gums, stomach, bowels, lungs, kidneys, etc.) may occur, and reach even a dangerous extent. The *lymphatic glands* are often swollen; the mucosæ of the nose and throat are hyperemic; the eyes are congested and the face flushed. The disease is characterized by well-marked leukopenia.

The *initial fever* lasts three or four days, and ends with a deep remission accompanied by sweating. All the symptoms now vanish save a slight soreness and stiffness, but after two or three days the characteristic symptoms (including a roseolar eruption) reappear. This terminal eruption is rubeolar, commencing on the palms and backs of the hands, and extending upward. It is circular, dusky red, and sometimes slightly elevated. It extends quickly to other parts, being best seen on the back, chest, upper arms, and thighs. The spots disappear on pressure, and never or rarely become petechial (Manson). The *second* febrile paroxysm is usually milder and shorter than the first.

The **duration** of the disease is from seven to ten days, the attack being followed by a slow convalescence, which may be interrupted by a relapse. The slowness of the recovery is due to persistence of the pains, mental depression, and marked physical prostration.

Complications.—Meningitis has been rarely noted. Convulsions sometimes occur in children, and severe catarrhal inflammations of certain mucosæ (bronchial, gastric) may develop. Insomnia is common. Hyperpyrexia and pericarditis occur, though exceptionally.

Diagnosis.—The diagnosis of the epidemic form of the disease is an easy one after observation of the first few cases, but it is difficult to discriminate sporadic cases from *rheumatism*. The course of the fever, however, differs in the two diseases, while the eruption belongs to the former alone. *Influenza* may resemble dengue. Influenza occurs in the cold season, and herpes is usually the only eruption; the joints are rarely involved; there is no recurrence of the fever, and serious complications are more frequent. The discovery of the bacillus of influenza is decisive, and the existence of an epidemic of either condition suggests the true nature of the disease. *Scarlet fever* has an erythematous eruption, but the fever is continuous, angina is present, and the arthritic symptoms are wanting. As a rule, dengue prevails only in tropical and subtropical countries.

Yellow fever has been mistaken for dengue, and the two affections may prevail together, as in the Galveston epidemic of 1897. The differential diagnosis is difficult, as there are points of similarity—time of appearance, geographic distribution, and the character of the febrile paroxysm. To show contrast, however, I have arranged the following table:

DENGUE	YELLOW FEVER
Affects all races.	Foreigners more especially.
Facies characteristic; face flushed.	Mucous membranes injected.
Irregular rise of fever, followed by remission, then a second moderate rise.	The temperature rises regularly. Duration of fever seventy-two hours.
Duration five to nine days.	
The pulse keeps pace with the fever.	Pulse falls while the fever is rising.
Eruption frequent (terminal rubeola).	Eruption quite rare.
Vomiting rare.	Vomiting frequent.
Urine never contains albumin (?).	Urine early albuminous.
Jaundice absent.	Jaundice present and early appearing.
Hemorrhages from mucous outlets, generally slight, and black vomit rare.	Hemorrhages common and severe. Black vomit an alarming symptom.
Muscular and joint pains present.	Absent.
Prognosis favorable.	Often fatal.
Serum diagnosis valueless. There is a well-marked leukopenia.	Serum diagnosis present in 66 per cent. of cases; no leukopenia.
Second attacks common.	No second attacks.

The **prognosis** is, with rare exceptions, favorable, dangers arising only in the serious forms, particularly those showing hemorrhages.

Treatment.—Indications: (a) to preserve the patient's strength, and (b) to meet certain leading symptoms. The first is to be met by enjoining rest in bed, by a generous diet, and by the use of stimulants and tonics during convalescence. The fever may demand treatment, and when this is high, hydrotherapy is indicated. For the intolerable pains morphin is to be administered hypodermically. Efforts to destroy the *Culex fatigans* should be instituted. Isolation should be practised.

THE PLAGUE

(*Bubonic Plague; Black Death*)

Definition.—A specific contagious disease occurring chiefly in unsanitary surroundings and characterized by high fever and cutaneous symptoms (petechiæ, etc.). Its course is severe and rapid, and it occurs in epidemics.

Historic Summary.—An Oriental disease, the plague has long been endemic in certain portions of India. Most European countries have in the past been visited by epidemics of the malady, and among the most famous was the truly pandemic prevalence of "black death" in Eupore during the fourteenth century. Another virulent outbreak occurred in London in 1665, destroying more than 70,000 persons. In May, 1894, a severe epidemic prevailed in Canton and Hong-Kong, to which cities it had been imported from Northern India. In September, 1896, the plague appeared in Bombay and the Bombay Presidency. Since then the plague has shown periods of decrease followed by others of decided increase, and the total plague statistics for the Bombay Presidency from September, 1896, to January 13, 1899, are 214,197 cases and 169,240 deaths. In the autumn of 1899, 2 cases were brought to New York harbor, and on March 6, 1900, it appeared in the Chinese quarters of San Francisco, and 31 cases were officially reported between that date and February

13, 1901. It has reached several European ports—Oporto, Hamburg, Glasgow, London. W. J. Simpson has given a graphic account of the history and distribution of the plague.

Etiology.—**BACTERIOLOGY.**—During the epidemic at Hong-Kong, Kitasato and Yersin, working independently (1894), discovered the special organism of the plague (*Bacillus pestis bubonica*). It stains deeply at the ends, giving the appearance of a pair of micrococci, but is really a short rod-bacillus with rounded ends. Pure cultures can be made, and when animals (mice, rats, guinea-pigs, rabbits) are inoculated with these the symptoms of the disease are produced.

Predisposing Causes.—There are (a) unhygienic conditions, and (b) seasons. Broca states that epidemics of pneumonic plague occur in winter, and those of bubonic form in summer.

Inside the body the bacillus has been found in the lungs (plague-pneumonia—where it is often combined with the pneumococcus and staphylococcus), in the enlarged glands, in the pus from the buboes and the blood. *Outside* the body among infected materials are dust from sputum, plague-infected flies, fleas, the excreta, food, and soil.

Modes of Transmission and Entrance into the Body.—According to Kitasato, the bacillus enters either through the digestive (rare) or respiratory tract or the skin (*e. g.*, abrasions of the feet, bites of sucking insects). The point of infection is usually a gland or group of glands (Flexner) causing the primary bubo. The bubonic pest is spread by two principal factors—the rat and man (Simond). In most outbreaks of human plague rats had the disease both before and during the epidemic (Clemow). The rat is the carrier from house to house. Infected rats, ship-born, are the most probable carriers of the disease for long distances. Infected humans are recognized at quarantine stations; infected rats escape from ships without any evidence of bearing plague germs. Flies, fleas, ants, and other insects may act as carriers from rat to man. The rat flea carries the contagion from one rat to another. Nuttall's studies indicate that transmission of the poison by stinging insects is extremely rare. Certain animals besides rats (mice, tarabagans, dogs, cats, rabbits, pigs, horses) may become infected and transmit the disease to healthy animals. McCoy and others have found the plague bacillus, pathogenic for rats and guinea-pigs, in the ground squirrel. Yersin established the contagion of plague by keeping inoculated rats and healthy mice in the same place (Payne, in Allbutt's *System*). The disease is commonly transmitted by foci of the infection (houses, ships), by fomites, and possibly by plague-infected food and immune carriers.

Clinical History.—**VARIETIES.**—The classification is based on the particular system of the body principally invaded as follows: (a) Bubonic (glandular); (b) septicemic (circulatory); (c) pneumonic. Formerly two distinct forms, (1) pestis minor, or larval plague, and (2) pestis major, or the severe epidemic form, were recognized.

INCUBATION.—This lasts from two to five or, rarely, eight days. In malignant epidemics it may be but three or four hours. Prodromata may be observed for from twelve to twenty-four hours; they are intense headache, vertigo, and an unsteady gait. The physiognomy is stupid.

(a) **BUBONIC TYPE.**—This type corresponds to the so-called pestis minor (*vide ante*), often a forerunner of severe epidemics. It is characterized by swelling of the lymphatics, lasting about a fortnight, with slight general disturbance, as a rule. The bubonic, however, may merge into the septicemic or pneumonic forms. Such symptoms as halting speech, staggering

gait, great prostration, a peculiar physiognomy, and more or less lymphatic involvement are common to all varieties.

(b) **SEPTICEMIC TYPE.**—Invasion may be abrupt; less commonly it is preceded by the prodromes mentioned above; and rarely bilious vomiting or hematemesis are the ushering-in symptoms. A prolonged rigor or repeated shiverings occur. The temperature does not rise to a high level, 100° F. (37.7° C.), owing to profound prostration, and the pulse becomes rapid and thread-like, although variable in force and character. Delirium or coma tends to supervene. Debility may now be extreme, and the patient may die in the initial period. More commonly this threatened collapse is survived, and then (second to the fifth day) the most characteristic feature almost always appears—secondary buboes or inflammation of the lymph-glands, most commonly the inguinal, but also the axillary and cervical. The latter enlarge and are painful. Resolution may occur, or they may remain unchanged, particularly in fatal cases. Suppuration may also occur, and rarely gangrene, forming the so-called carbuncle. Petechiæ and the hemorrhagic diathesis, as shown by bleedings from the lungs, stomach, and intestines, arise in the worst forms. In this variety blood obtained by puncture of spleen, liver, and other organs shows the microbe in pure culture.

(c) **PNEUMONIC TYPE.**—Pneumonic plague, where primary localization of the disease in lungs occurs, commences with a rigor, malaise, headache, nausea, vomiting, and pains in the limbs. Fever, varying in range from 102° to 105° F. (38.8°–40.5° C.), hurried breathing with oppression, cough, and blood-tinged sputum soon appear. The physical signs, especially the stethoscopic, may be those of bronchopneumonia. The local symptoms grow worse, cyanosis, delirium, and later coma supervene, while the heart's action fails and death occurs on the third, fourth, or fifth days of the illness. In cases which recover or become protracted, buboes may appear, and rarely these develop early in plague pneumonia.

(d) **AN INTESTINAL TYPE**, with marked hematemesis, bloody diarrhea, and abdominal pains, also occurs.

(e) **ABORTIVE TYPE** (*Pestis Ambulans*).—Certain epidemics are distinguishable by the larger proportion of mild cases (Manson). The patient may be so little inconvenienced as to be able to be about throughout the illness.

PLAGUE PNEUMONIA may also be secondary to, or symptomatic of, other types, the microbe having reached the lung metastatically, or possibly has been inhaled into the lungs. This form likewise simulates lobular pneumonia in its clinical features, and a pure growth of the plague bacillus can be obtained on making cultures from the sputum.

Sequelæ.—Paralysis of various kinds, myocardial weakness, and recurring suppuration of buboes are the principal sequels of the disease.

Relapses rarely occur, and are dangerous.

The **diagnosis** can be made with ease and certainty when the disease occurs in endemic centers, but when it occurs elsewhere its recognition offers some difficulty. The bubonic type is easily recognized, as a rule. On the other hand, to differentiate between primary plague pneumonia and ordinary lobar or bronchopneumonia is puzzling. A certain diagnosis rests upon bacteriologic evidence alone. Blood-cultures are positive in the early stages of the disease. The agglutination reaction does not become positive until after four or more days have elapsed.

Prognosis and Mortality.—The death-rate is high, ranging from 40 per cent. (rare) to 80 or even 90 per cent. Among favorable indications is suppuration of the buboes. On the other hand, a rapid disappearance of a

group of swollen glands is a bad augury. Additional unfavorable indications are plague-pneumonia, intense toxic features, with cardiac dilatation, purpuric spots ("tokens"), and hemorrhages.

Treatment.—**PROPHYLAXIS.**—The precautions to be taken by the individual relate to the abandoning of all unsanitary habits, the isolation of the sick, and the avoidance of prolonged contact with infected patients or dwellings. Personal cleanliness and freedom from abrasion of the lower extremities are important prophylactic measures (White). It would seem that doctors and even nurses and attendants in well-ordered and properly ventilated hospitals rarely take the plague.

The prophylaxis of the public embraces: (a) Isolation of the sick and thorough disinfection of the sick-room, the bed and bed-linen, the vomitus, and the stools. Kitasato advocates steaming the bed at 212° F. (100° C.) for one hour, or exposure for a few hours to sunlight, and the burning of all infected articles. "After recovery the patient is to be kept in isolation for at least one month." Cases of *pestis ambulans* must be found and treated on account of their bearing on the spread of the graver types. The infected houses are to be thoroughly disinfected, and a pure water-supply procured. (b) Protective inoculation or treatment by vaccination of healthy persons seems efficient, though "the immunity following prophylactic vaccination is relatively short" (Park), and is, therefore, of value chiefly in the presence of an epidemic. Haffkine states that at Hubli the difference in mortality of those inoculated and of those uninoculated averages from 80 to 90 per cent. The dose was 2.5 c.c. The experiments of Strong and Teague indicate that prophylactic inoculation does not protect against pneumonic infection in man. Calmette recommends Yersin's antiplague serum for prophylactic purposes in preference to Haffkine's vaccine. Strong advocates the injection of attenuated living cultures of *Bacillus pestis* as a method of immunization. Buchanan advocates the keeping of cats to destroy the root of the trouble—the rats. The methods of plague prevention used by United States Public Health officers include the catching and destruction of rats, rat-proofing buildings, wharves, etc., rat-guards on lines from boats to the shore, the fending off of boats at least eight feet from the shore and the elevation of gangways when not in use, and the extermination of all other rodents, for example, the ground squirrel.

TREATMENT OF THE ATTACKS.—The diet should be liquid and nourishing, while free stimulation is demanded from the onset. *Medicines* are used to combat symptoms as they arise. Delirium and pain are to be met by morphin or hyoscin, and high temperature by hydrotherapy.

Local Treatment.—Cantlie does not believe in local measures before suppuration occurs. On the other hand, Nesfield notes that early incision into a plague gland produces an immediate improvement in the patient's condition.¹

Specific Therapy.—Antiplague serum exercises a specific action (Yersin). Of 26 cases treated, 2 died—a mortality of 7.6 per cent. Calmette states that serum injection provokes rapid destruction of the bacilli by phagocytosis. As a curative dose, 100 c.c. must be injected intravenously, and repeated in twenty-four hours if there be fever still. Choksy concludes that in the Yersin-Roux antiplague serum we possess an efficacious remedy, especially if used during the first few or even twenty-four hours, serious complications being averted.

¹ *The Lancet*, London, November 4, 1911.

ERYSIPELAS

(*St. Anthony's Fire*)

Definition.—A specific, acute contagious disease, characterized by a special inflammation of the skin and subcutaneous tissues, with a tendency to spread, high fever, moderate prostration, a disposition to mixed infection, and an average duration of fourteen days. It usually occurs as an endemic disease, though also in epidemic form.

Pathology.—Erysipelas is a specific inflammation involving the skin, subcutaneous and, less commonly, the mucous surfaces. When inflammation extends to the subcutaneous connective tissue there follows, as a rule, suppuration. The causative cocci are found in the superficial lymph-vessels and spaces of the affected skin. Beyond the border of the inflamed region they occupy chiefly the lymph-vessels, where they are finally overpowered by the phagocytic leukocytes. Microscopic examination reveals the changes of simple inflammation. Pericarditis, endocarditis (rarely malignant endocarditis), pleuritis, and nephritis may be noted.

Etiology.—**BACTERIOLOGY.**—The specific cause of the disease was held at one time to be the *Streptococcus erysipelatis*, but by some it is now believed that this organism is identical with the *Streptococcus pyogenes*, and by others that, although essentially the latter organism, it takes on certain characteristics while in the lymph-spaces of the skin which differentiate it from the ordinary hemolytic streptococcus. Favorite situations of the streptococci are the lymph-vessels of the skin and the cutaneous connective tissue. It is especially abundant near the advancing border of the erysipelatous area, but is rarely found in the blood-vessels, and in blood-serum it is caused to disappear by the action of the phagocytes; yet in exceptional cases intra-uterine infection has occurred.

PREDISPOSING CAUSES.—(1) **Season.**—In a paper on "Seasonal Influences in Erysipelas, with Statistics," I have shown, as the result of an analysis of 2010 cases collected from different sources, that the various seasons of the year exercise a potent influence upon the frequency of this affection. Thus month by month the cases increase, in slightly varying ratio, from August to April, the latter month giving the greatest number, and then there is a rapid decrease from April to August, when we find the smallest number. Again, one-half of all the cases occur during the months of February, March, April, and May, and 15.9 per cent. during the month of April alone. It was found that a low barometer and mean relative humidity invariably correspond with the annual period in which the greatest number of cases occur, and that the highest percentage of relative humidity corresponds with the months affording the fewest cases.

(2) **Age.**—From the notes of 1894 cases I found that in 25.8 per cent. the age of the patient was between twenty and thirty years. After fifty years the cases decrease rapidly, and more than 15 per cent. occur before the age of twenty. The great liability of newborn infants is well known.

(3) **Sex.**—This factor was noted in 1767 cases, and a marked preponderance of the male over the female sex was noted (about 3 to 2).

(4) **Previous Attacks.**—Of 450 cases, there had been previous attacks in 39 (8.6 per cent.), in one instance four, and in another seven, while second and third recurrences were not uncommon.

(5) **Family predisposition** exercises a slight though decided influence.

(6) **Certain Antecedent Affections.**—Dr. M. Booth Miller examined the history of 301 cases, and found that acute coryza preceded the attack in 13

instances. Slight lesions of the Schneiderian mucous membrane may be assumed to exist in such instances. That certain chronic diseases (chronic Bright's, phthisis, organic heart disease, chronic alcoholism, cirrhosis of the liver) augment a receptivity to the complaint has also been brought to light by my researches.

(7) **Slight Injuries, Abrasions, etc.**—Erysipelas will not develop on a surface which does not present a break, but with this present may do so though the latter be so trivial as to escape observation. Slight abrasions and fissures, either in the mucous membrane of the nose or in the skin of the face or ear, as well as all forms of slight injuries, are liable to furnish a highway for the organism. Yet in 643 out of the 2010 cases mentioned above, previous lesions were noted in but 13. Women who have been recently delivered and persons subjected to surgical operations are peculiarly liable, and any deep-seated focus of irritation (necrotic bone, chronic abscess, appendicitis) may give rise to erysipelas.

(8) **Antihygienic Surroundings.**—These doubtless predispose to the affection, as has been shown by the prevalence of erysipelas in hospitals and institutions in which the sanitary arrangements were markedly faulty.

Modes of Conveyance of the Contagion.—The latter may be air-borne for short distances at least. It has been collected from the air of rooms and wards occupied by erysipelas patients. It is usually transferred for a longer or shorter distance by fomites, by instruments, unclean hands, etc. The infecting microbe is inoculated through small and even invisible lesions of the skin about the nose and mouth (spontaneous or facial erysipelas). It is possible for intravascular infection to occur.

Clinical History.—I shall discuss only *idiopathic* erysipelas, the traumatic variety falling within the domain of surgical treatises.

Incubation.—This is somewhat varied, though it ranges usually from seven to fourteen days. The *prodromal symptoms* are, for the most part, general in character, consisting in headache, restlessness, cough and sore throat, anorexia, and slight or moderate pyrexia. These endure for a very variable period—from a few hours to several days.

Invasion Stage.—The symptoms are (1) local and (2) general.

(1) At first the affected part feels hot, tense, painful, and is tender to the touch. A circumscribed area becomes red, swollen, firm, and shining, and simultaneously the subjective symptoms (pain, heat, etc.) become aggravated. The *point of election* is usually on the nose, but it may be on the ear, the face, or elsewhere about the head. The inflamed, swollen zone spreads, chiefly in the direction of one or the other side of the head. Separating the diseased from the unaffected skin there is a sharp line of demarcation—an elevated brawny ridge—this ridge presents a “zigzag irregularity of outline like the burned edges of a sheet of paper” (Warren). While the inflammation is advancing there may be noted, beyond the border of the latter, little red streaks and spots that grow in area till at last they become confluent. Any natural prominence or fold in the integument may prevent extension of the inflammation (*e. g.*, nasolabial folds). In cases of *average severity* the face is much swollen, the eyes closed on account of tumefaction of the eyelids, the ears greatly enlarged (better marked on one side than the other), the scalp swollen and tender, and the facial lineaments often changed beyond recognition. Tenderness to pressure is a constant feature. In a minority of the cases the inflammatory process extends from the head to the arms, to the trunk, and even to the lower extremities (*erysipelas migrans*), and in such instances the face may be healed while the disease is yet extending. When the disease is arrested the peripheral ridge ceases to extend and grows pale.

The epidermal layer may become elevated over circumscribed areas,

Three other forms—namely, *phlegmonous* or cellulocutaneous, *relapsing* erysipelas, and *erysipelas neonatorum*—should be mentioned. The first exhibits an inflammation of the subcutaneous tissue, which tends to suppurate. Relapsing erysipelas constitutes the chronic form of the disease, recurring at intervals, and usually in the same locality. It is commonly due to some deep-seated focus of suppuration. Erysipelas neonatorum is the result of infection of the stump of the umbilical cord. From the navel the inflammation spreads to the thighs and genitals. As a rule, there is fever, followed in a few days by fatal collapse.

Sequelæ.—The hair often falls, but it is usually replaced by a fresh crop. Otitis media and chronic nephritis may date from an attack of erysipelas. *Per contra*, erysipelas is reputed to be curative of certain affections (eczema, lupus, carcinoma, sarcoma).

Out of 476 cases collected by me relapses occurred in 54 (11.3 per cent.), and in 1 of these instances 5 relapses occurred; in 2 others, 4.

The **diagnosis** is made with ease after the eruption has fully developed, and its appearance, seat, and behavior, particularly the manner of extension of the brawny, ridge-like edge (best marked on the forehead), are the features that distinguish it from every other disease. A bacteriologic diagnosis is often possible, the streptococcus being found in the pus and secretions from the nasopharynx.

Differential Diagnosis.—*Erythema* produces superficial redness, but is not attended with heat, swelling, or fever. *Urticaria* assumes the form of pale-red circular wheals, which cause marked itching and appear in successive crops, often disappearing in the course of a few hours. *Acute eczema* of the face, when intense, may resemble erysipelas; but it lacks the peculiar border and mode of progression so characteristic of the latter disease. Again, eczema produces troublesome itching, and the swelling is less than in erysipelas. *Chronic erythematous eczema* is met with later in life, is without fever, without any considerable swelling or pain, and excites intense itching. *Eczema nodosum* is characterized by its nodosities near the joints.

Course and Duration.—In my own experience, based upon 1880 cases, the average duration (including the prodromal stage and period of convalescence) in persons under forty years of age is fourteen day. The course of the disease is much lengthened by complications, the pre-existence of chronic affections, and by age (after the fiftieth year).

The **prognosis** is favorable, and it is rare for erysipelas to assume a malignant type. Perhaps the chief dangers lie in certain complications, especially extensive suppuration, pneumonia, acute nephritis, delirium tremens, etc. Acute articular rheumatism is comparatively harmless; but *previous debility*, especially if dependent upon chronic diseases, as syphilis, chronic rheumatism, gout, tuberculosis, organic disease of the heart, and the like, increases the percentage of deaths considerably. Again, age has a positive influence upon the mortality, which it augments moderately after the forty-fifth year, and most decidedly after the sixtieth year. Of 2663 deaths due to erysipelas (United States Census Report), the death-rate per 100,000 inhabitants was as follows: under five years, 31.34; five to fifteen years, 0.81; fifteen to forty-five years, 2.80; forty-five to sixty-five years, 8.88; sixty-five and over, 38.55 (Wm. L. Rodman). Death is due to exhaustion.

The **mortality rate** is low, as shown by the results of my own collective investigations into the subject. I found the general average death-rate to be 5.6 per cent., while in cases from private practice it was 4 per cent. In persons over seventy years it was 46 per cent. The traumatic cases gave a mortality of 14.5 per cent.

Treatment.—The treatment of erysipelas falls naturally into four subdivisions: (1) *Dietetic*, (2) *constitutional*, (3) *local*, (4) *prophylactic*.

(1) **Dietetic.**—Proper attention to the diet is of the first importance. It must be generous and composed of highly nutritious articles, and if the temperature be high, only liquid forms of nourishment should be administered in definite quantities and at stated, brief intervals. Rectal alimentation should be resorted to if the stomach rejects a suitable dietary. Lack of attention to the patient's diet during the primary attack tends to increase the frequency of relapse. In persons over fifty years of age, and in those in whom the vitality is lowered on account of previous chronic diseases, correct alimentation is of paramount importance.

(2) **Constitutional.**—When, despite an appropriate diet, the pulse becomes very rapid and feeble, the heart's first sound indistinct, and the tongue dry, indications for the use of stimulants exist. Strychnin gives prompt results and digitalis may be used in severe cases. In marked gastric irritability champagne is to be preferred. The eliminative organs, especially the kidneys, are to be stimulated by free water drinking so as to rid the economy of the toxins.

The tincture of the chlorid of iron was first extensively used in this disease by English authorities, and was formerly regarded by most clinicians as a truly specific remedy. In 74 cases of erysipelas which were treated by this remedy alone, the average quantity being 1 dram (4.0) daily in divided doses, in the Pennsylvania Hospital by Drs. Lewis, DaCosta, Longstreth, Meigs, and others, the death-rate was 4 per cent. Other preparations of iron, however, are equally efficacious. Quinin is a valuable remedy in erysipelas, and during the past twelve years I have employed it in not less than 30 cases, confining its use to instances in which the temperature touched 103° F. (39.4° C.), and, with a single exception, in uncomplicated cases (22 in number) the nocturnal remissions were decidedly greater. In every instance iron in some form was administered simultaneously. Numerous *antiseptic* remedies have been recommended.

Certain *symptoms* demand internal medication. When the fever is high, its reduction is best accomplished by means of cold spongings combined with the ice-cap, or cold or gradually cooled baths. Guaiacol applied externally has recently been employed for the same purpose.

For *marked nervous phenomena*, such as pain, sleeplessness, and active delirium, hyoscin hydrobromate (gr. $\frac{1}{100}$ —0.0006) has been used hypodermically at the Medico-Chirurgical, Pennsylvania, and Philadelphia hospitals. It should not be employed when the heart power is deficient. For the same indication we may utilize the following: Sodium bromid, gr. v (0.3), every two hours, or gr. xx to xxx (1.3–2.0) at night; morphin, gr. $\frac{1}{8}$ (0.008), and chloral, gr. x (0.6), in combination every half-hour for three doses; potassium bromid, gr. x (0.6), and tincture of cannabis indica, ℥x (0.6), in combination, and morphin, gr. $\frac{1}{8}$ (0.01), hypodermically.

The treatment of the various *complications* must be conducted in accordance with general principles applicable to each.

Specific Therapy.—Andre, Robinson, Cox, Anderson, and others have reported instances of the successful use of antistreptococcic serum. The serum is injected subcutaneously; its influence endures over several days, but it is important that the injections are repeated at forty-eight-hour intervals. Marmorek's serum (care being taken that it is not too old) is to be preferred. G. H. Sherman reports uniformly good results from the use of stock vaccines (streptococcic), especially when used early in the course of the disease. The dose is 20,000,000 for the adult, and where local improvement with the reduc-

tion of temperature does not occur, this should be repeated at the end of twenty-four hours.

(3) **Local measures** have always held a prominent place in the treatment of erysipelas. In my paper previously cited those most frequently used were elm (37 cases); lead water and laudanum (20 cases); carbolic acid (1 : 40), injected subcutaneously (18 cases); zinc oxid (14 cases); mercuric chlorid solution (14 cases); ichthyol ointment with lanolin (8 cases).

R. Ichthyolis,	℥ss (15.0);
Camphoræ,	℥ss (2.0);
Unguenti iodi,	q. s. ad ℥ij (60.0).—M.
Sig. Apply as directed.	

Many of these preparations were prescribed for their effect in excluding the air—a leading indication. This I am in the habit of meeting by the use of carbolized vaselin or cool carbolized oil. Ichthyol-collodion (strength 10 to 50 per cent.), painted over the erysipelatous area and also over the surrounding healthy skin for 2 or 3 cm., has been advocated.

Tucker recommends the application of a saturated solution of magnesium sulphate in water. This is applied in facial cases on a mask consisting of from fifteen to twenty thicknesses of ordinary gauze, of sufficient size to extend beyond the area involved, with a small opening to permit breathing, but none for the eyes. After thorough saturation with the solution, the mask is applied and covered with oiled silk or wax paper; it is wetted often enough to assure a moist dressing—usually every second hour. The dressing should not be removed oftener than once in twelve hours to permit an inspection of the parts.

A knowledge of the microbic nature of erysipelas has led to the local application of numerous antiseptic remedies. Mention has been made of the method of injecting carbolic acid. Here the aim is to check the spread of the inflammatory process by inserting the needle at numerous points just beyond the inflamed border. Arneth found that painting the region and vicinity three or four times daily with a 5 per cent. oil solution of phenol was most effectual for the purpose of preventing extension of the affected area. In the statistics before given a solution of mercuric chlorid (1 : 4000) was used locally in 14 instances, to which I can add the results of 12 others at the Medico-Chirurgical Hospital and in private practice. In a few cases it was injected beneath the skin, as in the case of the carbolic acid. More recently it has been recommended to scarify the affected part and follow with the application of a solution of mercuric chlorid. In view of the fact that the streptococcus is found chiefly in the more superficial channels of the corium, it follows that it may be attacked directly by the mercuric chlorid solution when the latter is used after scarification. G. L. Curtis advises sodium sulphate, which acts by depriving the germs of oxygen, as a local application. MacLennan advocates a saturated solution of picric acid as a local remedy. Where the skin is tightly stretched or bound to the tissues lying beneath there is always a tendency for the onward progress of the disease to stop. For this reason Wölfler recommends stretching the skin with adhesive plaster strips. The strips are put on about $\frac{1}{2}$ inch beyond the margin of the inflammation and pulled as tightly as possible. Frequently the straps will completely limit the inflammatory area. Avata and Woodyatt¹ treated 104 cases of erysipelas at the Base Hospital at Camp Cody, obtaining the best results from the collodion circumscription method.

(4) **Prophylaxis** embraces isolation and care of the skin of the whole

¹ *Jour. Amer. Med. Assoc.*, 1918, lxxi, 900.

body. Bathing with a boric-acid wash (3 per cent.), at intervals of several hours, so as to disinfect the desquamating epidermis, removes a source of danger. It is probable that relapses are sometimes due to auto-infection. Frequent change of the body-linen is to be advised and removal to another room during convalescence may prevent a relapse. Admission of erysipelatous patients to hospitals should be refused except that such institutions be provided with an isolation building.

DIPHTHERIA

(*Diphtheritis; Angina Maligna; Croup*)

Definition.—An acute, contagious disease caused by the Klebs-Löffler bacillus, and characterized, anatomically, by a croupous-diphtheritic faucitis, less commonly rhinitis and laryngitis. Clinically, it is characterized by irregular fever, prostration, and albuminuria; also by the secondary development of toxemia, and often cardiac failure. It is commonly followed by peculiar paralyses. In large municipalities it behaves endemically, and from time to time epidemically. The disease, however, is less prevalent than formerly. In spite of this, however, the yearly mortality is over 23,000.

Pseudodiphtheria.—There are forms of inflammation occurring most frequently in the pharynx and adjacent air-passages (and also in many other parts of the body) that are attended with the formation of a pseudomembrane, and are not caused by the Klebs-Löffler bacillus. These cases have been studied exhaustively by Prudden and others, who have usually found the streptococcus. The latter, however, has been found in the inflamed mucous surfaces met with in erysipelas, scarlatina, and measles. Vincent's angina is a form of pseudodiphtheria.

Pathology.—The true diphtheritic inflammation has for its chief pathologic peculiarity the production of a fibrinous exudate. When the inflammation is superficial and of a mild grade, a croupous membrane is produced which can be easily removed from the mucosa, which it covers. In the severer types of the affection, however, the fibrinous membrane infiltrates all the layers of the mucosa, which undergoes necrosis more or less nearly complete. In the severest forms the submucous layer may also become necrotic. It is to be borne in mind that the production of the fibrinous exudate in diphtheria is always preceded by coagulation-necrosis of the epithelium. The membrane formation is accompanied by changes in the underlying tissue which represent a combination of degeneration and exudation (Councilman, Mallory, and Pearce). The mucous membrane surrounding the exudate is hyperemic, more or less edematous, and the seat of mucopurulent secretions.

The Pseudomembrane.—Its composition comprises fibrin, pus, disintegrated leukocytes, flakes of necrosed epithelium, bacilli, and sometimes red blood-corpuscles. The fibrin has two main sources: (a) "The fibrinogen of the inflammatory matter," which transudes through the capillary walls, and (b) disintegrated, migratory leukocytes, which form branching fibrillæ. Weigert holds that the inflammatory exudation is coagulated by a ferment derived from the disintegrated leukocytes.

The Klebs-Löffler bacilli are found in the meshes of the fibrillæ, in the granular fibrin, and on the adjacent mucous membrane; they are never found growing in living tissue, but always in necrotic tissue. Other microorganisms are associated (streptococci, staphylococci, etc.). The membrane presents a grayish-white color; it is thick, firm, and adherent, so that its removal entire cannot be effected without great difficulty, and without, as a

rule, injury to the surface, as shown by bleeding, etc. The character of the pseudomembrane is affected by the nature of the underlying structure; thus in the pharynx it is firmer and less easily separable than in the larynx and trachea, where a distinct basement-membrane is found (Flexner). As the membrane becomes older its color is apt to grow darker, becoming yellow or even dark brown. It sometimes becomes gangrenous, and softens or disintegrates, with the production of a very offensive brownish, semiliquid excretion. The advancing edge of the false membrane is usually thin. On the other hand, when the process has become arrested the edge is apt to look raised or wrinkled, and later it may be distinctly curled up.

The membrane may extend downward into the ramifications of the bronchi. In such cases there is apt to be a lobular pneumonia, but the lung may be invaded by the bacillus without any clinical indications. Lung infection due to the streptococci and (less commonly) the pneumococci is common. A generalized bronchitis extending to the smaller bronchi is common from the irritation of aspirated substances. In rare cases the membrane has spread into the esophagus and even into the stomach.

After separation of a croupous membrane repair consists merely in a restoration of the epithelial layer—a process which is initiated by the fragments of epithelium that remain along the edges of the diseased area, and proceeds centrally. On the other hand, in true diphtheria, with necrosis (more or less complete) of the mucosa, sloughing occurs, and the missing structures are replaced by cicatricial tissues.

The Heart.—The histologic changes may be of the parenchymatous variety, but only in mild instances; whereas in severer cases fatty degeneration is conspicuous. In still other cases the chief pathologic characteristic is an interstitial myocarditis, and rarely the lesions of pericarditis and endocarditis have been noted. The heart is by no means always involved.

The **spleen** is commonly enlarged, though not to an excessive degree. The **blood** is dark, its coagulability is greatly diminished, and Canon and Frosch have in a few cases found the bacilli in the blood of those dying of diphtheria. The red corpuscles are somewhat decreased in number during the course of the disease, while the white corpuscles are increased. Bouchut and Dulinsay consider the grade of leukocytosis of prognostic value, and claim that it varies directly with the severity. The **lymphatic glands** of the neck become swollen, as a rule, and are often greatly enlarged, but they show little tendency to suppurate. In pronouncedly septic cases in which a mixed infection is found by culture a good deal of tumefaction of the neck occurs, this sometimes even obliterating the normal contour from the jaw to clavicle.

The **kidneys** show degenerative changes, the usual *kidney lesion* being a hyperemic swelling with edema of the interstitial tissues, and often hemorrhagic spots in the cortex. Sometimes there is a marked glomerulonephritis, and rarely a diffuse granular degeneration of the epithelium.

The **nerves**, in cases of paralysis, have shown parenchymatous and interstitial inflammatory lesions. In paralysis of throat muscles (*i. e.*, those near the locality of the pseudomembranous inflammation) the latter show also round-cell infiltration and fatty degeneration of the fibers. The nerve-fibers of the central nervous system may also show fatty degenerative changes. In fatal cases lesions have been found to engage either the meninges, the cerebro-spinal substance, or the nerves.

Etiology.—True diphtheria is caused by the Klebs-Löffler bacillus, and all cases of supposed diphtheria in which the bacillus is absent are to be regarded as non-diphtheritic. The etiologic is, therefore, quite different from the pathologic significance of this term. Researches have removed all doubt as to the specific nature of the Klebs-Löffler bacillus.

Bacteriology.—The *Bacillus diphtheriæ* nearly equals in length that of the *Bacillus tuberculosis*, and is twice the diameter of the latter. It has rounded extremities, which are also frequently bulbous, giving it the appearance of a dumb-bell. At times one end only is clubbed or, more rarely, one or both ends appear pointed. The bacilli are immobile, do not form spores, and stain readily, the best agent being alkaline methylene-blue. Their manner of taking the stain is important. The bacilli show alternating segments of darker and lighter stained areas, and often minute dots showing a most intense and deep staining. They grow on most culture-media, but for clinical purposes Löffler's blood-serum is important (3 parts blood-serum and 1 part neutral or slightly alkaline nutritive bouillon, containing 1 per cent. of glucose). Inoculated on this, they outgrow all other organisms that may be present, and within eight hours or less show numerous spots, $\frac{1}{2}$ to 1 mm. in diameter, which have a dull surface and a dense white or somewhat yellowish color. The bacilli are semi-anaërobic, and thrive at the temperature of the human body; a temperature of 122° to 136.5° F. (50°–58° C.) causes their destruction in ten minutes.

Pseudodiphtheria Bacillus or *Bacillus Xerosis*.—From many cases, often showing no lesions, an organism may be obtained that is identical in appearance, manner of culture, growth, etc., with the *Bacillus diphtheriæ*, but inoculation with it causes no lesions. The works of Abbott, Roux, Yersin, and others seem to show that this is an attenuated form of the true bacillus, and varying grades of pathogenicity may be found between the two. The distinction from the pathogenic bacillus can only be made by determining the lack of infection after inoculation.

Site of Infection.—In the human family the seat of election of the *Bacillus diphtheriæ* is usually the faucial mucosa, and less frequently other mucous surfaces and abraded skin. The bacilli do not penetrate the mucosa, and hence do not find their way into the lymphatic or circulatory system, but remain at or very near the site of the local changes.

The toxins are absorbed from the diseased spots by the lymphatics and blood-vessels, and produce the general phenomena in uncomplicated cases.

Associated Bacteria.—With the Klebs-Löffler bacillus are usually found other bacteria, especially streptococci and staphylococci. These pass beyond the site of local infection, reaching the internal viscera and other structures, and, as will be seen hereafter, give rise to the serious septic element of the disease. W. Bloch and P. Sommerfeld, in studies on the pathogenicity of the Löffler bacillus, have verified the accepted statement with reference to the germ, their article being a good exposition of the present status of the bacteriology of diphtheria. From a study of 436 cases, the authors state that the Löffler bacillus was never found in pure culture, but always associated with other bacteria, among which streptococci played the greatest part. The two doctrines concerning the relation of streptococci to septic diphtheria are given, the one being that the streptococci increase the virulence of the diphtheria bacillus and cause sepsis by gaining access to the circulation; the other is that the diphtheria toxin by its effect on the organism prepares the way for an invasion by streptococci. The pneumococcus may be found.

Modes of Infection.—When the bacillus leaves the body of the sick it is contained in particles or shreds of the diphtheritic membrane or in the expired air. Infection may then occur, (a) *By direct contact* with the shreds of membrane thrown off—e. g., when the latter are ejected by coughing and lodge upon the conjunctivæ or faucial mucosa of bystanders. The deadly poison is sometimes transferred to the physician and attendants, with resulting infection, from the sucking of tracheotomy tubes. (b) *By inhaling the air* surrounding the patient (contagion). Infection by contagion, however, does not extend be-

yond a radius of a few feet from the patient. (c) An important manner of conveyance of the bacillus from the sick to the healthy is by *fomites*. The contagion adheres tenaciously to a great variety of objects (toys, clothing, library books, letters, slates, and drinking-cups in the public schools, etc.), and in this way the germs of diphtheria have been transferred over great distances and have given rise to the disease long after. The latter fact renders it difficult to trace certain cases to previous ones, to which they invariably owe their origin. (d) *Domestic animals* may be occasional carriers, especially cats. (e) The disease is kept alive in a community largely by virulent organisms in immune persons ("healthy carriers"—13.3 per cent.—Sobernheim). Rush, Miller, and Perkins define a carrier as a person who harbors virulent diphtheria bacilli for a period of twenty-one days or more after an attack. Keefer, Friedberg, and Aronson have shown that, in the great majority of cases, the carriers harbor the bacilli in the tonsils; a few carry the germs in the nose only, while a small group maintains the infection in both nose and tonsils.

Our knowledge as to how the infection occurs is incomplete. We know definitely the usual point of local infection in man, and also that a catarrhal mucosa or an open lesion of a mucous surface invites infection. It is not certain, however, that even a slight lesion of the mucous surface is essential to infection. Some writers claim still that the Klebs-Löffler bacillus may enter the blood through the respiratory system and give rise to primary constitutional symptoms, the local manifestations in the throat being secondary.

Predisposing Factors.—(1) *Age*.—This is the most important factor, diphtheria being, in the main, a disease of childhood. Most cases occur between the second and seventh years, while the receptivity diminishes rapidly after the tenth year. Instances have, however, been observed up to the fiftieth or even the sixtieth year. During the first year of life also it is rare. (2) *Sex*.—This is without appreciable influence. (3) *Season*.—Cases are more numerous in winter and spring than at other seasons. (4) *Climate*.—Diphtheria is met with less frequently in tropical than in temperate and cold climates. Humidity favors the propagation of the diphtheria germ, and hence damp cellars also promote the spread of the disease. (5) *Unhygienic Conditions*.—Unfavorable sanitary surroundings tend to lower vitality, thus increasing the susceptibility to the specific organism.

Immunity.—In the past few years much work has been done upon the problems of immunity in diphtheria. The well-known clinical fact that there is a natural immunity to diphtheria in many individuals has been shown to be due in the large majority of protected cases to the presence of antitoxin circulating in the blood. The antitoxin can definitely be determined by rather cumbersome and difficult methods. To obviate these difficulties Schick has devised a local skin reaction by which it can readily be determined if antitoxic immunity is present. The reaction depends upon the local irritant action of very small doses of diphtheria toxin, given into the skin, when antitoxin is not present in sufficient quantities to neutralize the toxin. Schick advises the intracutaneous injection of one-fiftieth minimum lethal dose for the guinea-pig in 0.1 c.c. of normal salt solution. A positive reaction appears in twenty-four to forty-eight hours, and is manifested by a circumscribed, indurated, red area, about 1 to 2 cm. in diameter, which persists for a week or ten days, scales superficially when fading, and leaves a small spot of persistent brown pigmentation. Pseudoreactions are to be differentiated by their earlier appearance and rapid disappearance, greater induration, and less clearly defined margins. The results of the test may be illustrated by the work of Zingher, who tested 2700 normal children, finding that only from 17 to 32 per cent. between the ages of two and sixteen give a positive result. The important application of the test may be best summarized by reference to the work of

Park. He finds that the method is of great reliability in showing antitoxic immunity to diphtheria; of value in determining the efficacy of immunization with mixtures of toxin and antitoxin; of great help in clearing up doubtful diagnoses (a carrier will give a negative reaction, whereas a case of beginning diphtheria will be positive); of advantage in testing the doctors and nurses of contagious disease hospitals and the inmates of institutions or private houses where diphtheria breaks out, thereby saving considerable expense to the institution and discomfort to the individual in whom the test is negative; of assistance in contagious disease hospitals in determining the immunity possibilities in those admitted to the scarlet fever and other wards.

Symptoms.—Incubation.—The *duration* of this period is from two to seven or ten days, and in a small percentage of the cases it may be longer. In virulent epidemics and when the disease is produced experimentally the incubation stage is short—from twelve hours to two or three days. The *prodromal indications* of diphtheria are not strikingly characteristic. They may either be acute in character or very mild; but usually the child will complain of feeling weary and indisposed to play, of sensations of chilliness, and of pain in the head, back, and limbs. In young children the onset of diphtheria may be marked by *convulsions*. There is nothing in this early stage of the disease to distinguish it from simple pharyngitis or tonsillitis. There may be some fever, not very high—an elevation of one or two degrees at most. The urine contains a small amount of albumin. R. Koch found diphtheria bacilli in the urine of 2 out of 26 diphtheria patients. The child often complains of discomfort in swallowing, and on examination the fauces will be found to be reddened, and in a short time the exudate will be found on the tonsils or soft palate. This is the usual type of **simple tonsillar diphtheria**.

Pharyngeal Diphtheria.—The symptoms are usually *slower of development* than in tonsillitis. The child is sluggish, looks heavy-eyed, languid, and pale for several days. The *fever* may not rise above 101° or 102° F. (38.3°–38.8° C.). On examining the throat, however, it is found to be swollen and red, and if *lividity* is more pronounced than the swelling, it suggests the true nature of the disease. The *membrane* begins on the tonsils in the form of small patches of yellow exudate, resembling the thick, cheesy plugs of inspissated dead epithelium and secretion which issue from the mouths of the follicles of the tonsils during the course of acute or chronic tonsillitis. Quite early this exudate is easily removable. The membrane spreads from the tonsils to the soft palate and half arches within a few days, and it may also appear on the pharyngeal wall. During this stage the throat may become much swollen and the tonsils greatly enlarged, frequently meeting in the median line. The *glands* immediately beneath the angle of the lower jaw on one or usually both sides become hard, painful, and slightly enlarged; the swelling of these glands is not great in mild forms, although their presence, in association with the foregoing symptoms, is an almost infallible indication of the disease. The child, as a rule, shows grave constitutional symptoms for a few days and albuminuria is present. Acetonuria is common in the severer forms of the disease. The *temperature* is not characteristic, as a rule not being high, and the pulse is rapid and weak, being out of proportion to the general indications of the disease. The blood-pressure is below normal in about one-third of the cases (Rolleston), and the degrees of depression bear a direct relation to the severity of the infection. In mild cases the symptoms abate by the end of the first week, and the pseudomembrane separates, leaving a red, inflamed surface behind. The child is prostrated for a number of weeks, and in about 20 per cent. of the cases neuritis, with its accompanying paralysis, occurs. Simple leukocytosis is present in diphtheria, although this symptom may be absent in mild cases.

Variations in Manifestation.—Diphtheria may exhibit variations as regards the seat of attack and the severity of the poisoning. In some epidemics the Klebs-Löffler bacillus seems to be more active or more virulent than in others. The severity of the attack does not seem to depend on the amount of the pseudomembrane, but rather, according to Rotch, upon three factors: (1) the virulence of the bacteria; (2) the local resistance; and (3) the general resistance. The mucous membrane of any part of the body (lips, tongue, conjunctivæ, vulva, or glans penis) may be the seat of the membranous growth.

Malignant Diphtheria.—The symptoms are severe from the commencement. There are one or at most two days of slight illness, and then alarming symptoms manifest themselves, *cardiac failure* possibly setting in without a specially severe local lesion. *Vomiting* and *high fever*, resembling the onset of scarlet fever, may initiate the attack; and within a few hours we may find extensive swelling at the angles of the jaws of stony hardness, an offensive bloody discharge coming from the nostrils, accompanied with difficulty in opening the mouth. If the *throat* is examined, there will be found extensive swelling of the tonsils, even to meeting, the uvula and soft palate being edematous and covered with much sloughy looking membrane. The *temperature* in severe cases soon reaches a point between 103° and 104° F. (39.4°–40° C.), while the *heart-beats* become exceedingly feeble. In a day or two the cellulitis extends, the face becomes edematous, the skin pits all over the face, neck, sternum, and chest wall. The patient becomes drowsy, cyanotic, and an erythematous rash may appear about the face, neck, and chest, while a purpuric rash is not infrequent. Death occurs in such cases within one week from toxemia. Cases of diphtheria septicemia have been recorded in the literature by Mahler and others.

Nasal Diphtheria.—In all severe cases of pharyngeal diphtheria the inflammatory process is likely to extend to the nasal mucous membrane. In some cases the nasal mucous membrane is found to be the first involved; the exudate may spread to the tonsils, involving the back of the soft palate and pharynx as well. In many cases of nasal diphtheria no membrane may be found during life; there may be only a purulent discharge with blood, the presence of which in the nasal passage obstructs breathing, giving rise to a bubbling sound, and rendering sleep troublesome and noisy. Cases have also been reported of formation of pseudomembrane in the nose with mild general symptoms, and from which organisms identical with diphtheria bacilli were obtained by culture. Sometimes the cases have recurring mild attacks of pseudomembranous inflammation of the nose, while the bacilli may be constantly present. It is probable that these cases may give rise to infections of like nature and even of true diphtheria. In nasal diphtheria the symptoms are quite as severe as in faucial diphtheria, and in cases in which the soft palate and tonsils are also involved the general symptoms, the depression, and also the albuminuria are apt to be well marked. In all cases of coryza with fever we should be guarded as to opinion, especially if an epidemic of diphtheria is prevalent at the time. The diphtheritic inflammation may spread from the nose to the conjunctivæ, with the formation of a false membrane, and much purulent discharge may escape from the eyes, the lids of which may be greatly swollen. In this place it is well to remember that in *measles* we sometimes have a form of membranous exudation occurring on the nasal mucous membrane, and as a primary disease—"rhinitis fibrinosis"—which is not always diphtheria. This disorder runs a favorable course, the membrane being less adherent than in diphtheria. Ravenel has collected 77 cases, and in 33 out of 41 cases examined bacteriologically the Klebs-Löffler bacillus was found. Constitutional symptoms were either slight or wanting.

Wound Diphtheria.—The bacillus will not live on normal skin, but when

the skin is cut or bruised, as after blistering or an eczematous condition, and when a moist, raw surface is present, this germ freely flourishes. Granulations also form a favorable soil. The diphtheritic germs may be introduced into the system during an operation, such as an excision of the tonsils or even a vaginal examination; and in newborn infants the granulating surface left after sloughing of the cord may become the seat of diphtheritic inflammation.

Laryngeal Diphtheria or Membranous Croup.—The exudate may appear first on the mucous membrane of the larynx, and in these cases the mucous membrane of the nose and pharynx may never give evidence of a false membrane. A close inspection of the posterior aspect of the palate and tonsils, however, may reveal a slight primary membranous formation in these situations. In laryngeal cases the first symptom is a *cough* of a *harsh, metallic, ringing character*, and never to be forgotten when once heard. The *temperature* may be slightly above normal, or even in many cases normal. The toxic absorption is slight on account of the locality affected, and the constitutional symptoms are usually mild. The *local symptoms*, however, are very alarming, and result from laryngeal obstruction, there being marked *dyspnea* with retraction of the intercostal and supraclavicular spaces, and later of the epigastrium and lower chest, with an increasing *cyanosis*. The child is soon restless, is forced to sit up to breathe, and for the same reason bends forward with its head thrown back. In these extreme cases unless relief is soon gained the child dies of suffocation. In many instances a slower form of suffocation may result from the extension of the membrane downward to the bronchi.

Complications.—Local complications may be mentioned—*e. g.*, *hemorrhage* from the nose and throat in the more severe ulcerative cases. *Skin rashes* are not unusual, especially *diffuse erythema*.

Bronchopneumonia is the most serious pulmonary complication of diphtheria. It is not produced by the Klebs-Löffler bacillus as a rule, but by the streptococcus or pneumococcus. Bronchopneumonia usually terminates laryngeal cases that have been operated upon.

Albuminuria is a constant symptom (not a complication) of the disease (*vide supra*), and is almost as certain in establishing a diagnosis of true diphtheria as a bacteriologic examination. It is met with in both mild and severe cases, and the greater the amount of albumin the more severe the case. Acute nephritis not infrequently complicates diphtheria; it is usually not accompanied by edema or anasarca. It may set in with suppression of urine.

Dysphagia may, by its constant existence throughout the disease, produce a profound impression on the general nutrition. Involvement of the *conjunctivæ* is a rare but grave complication.

Otitis media occurs frequently, and may be a troublesome complication as well as a sequel. Snow reports a case of diphtheria complicated with Escherich's pseudotetanus.

The most frequent *sequelæ* are anemia, chronic nasopharyngeal catarrh, and peripheral neuritis and its associated paralysis.

Anemia may so prolong convalescence as to expose the child to some intercurrent disorder. The *chronic nasopharyngeal catarrh* may be marked and offer a favorable ground for a new diphtheritic invasion. *Paralyses*—*e. g.*, palatal and cardiac—may appear in the first and second weeks of the disease. Other forms of paralysis occur later. Paralysis usually is first seen when the child attempts to swallow, and the food, especially if liquid, is regurgitated through the nose. This is due to a paralysis of the muscles of the soft palate, which also produces a peculiar alteration of the voice. The paralysis may take a general form, such as is seen in multiple neuritis, the lower extremities being affected and the knee-jerk absent. It may extend to the external ocular muscles and cause squint; to the ciliary muscles and cause dimness of vision

from unequal accommodation; or to the muscles of the trunk in general, producing wide-spread paralysis. The child, unable to hold anything, may stagger about as if intoxicated, so much so as to suggest the existence of a cerebral tumor. The disturbance of vision and the absence of the patellar tendon reflex has in adults led to a mistaken diagnosis of *locomotor ataxia*. Loss of taste, deafness, and sensitiveness of skin to pain are not infrequent. On the other hand, sensations of heat, cold, and touch may be unimpaired. Thus, paralysis is to diphtheria what dropsy is to scarlet fever—a proof positive of the disease. In many sudden deaths occurring in early diphtheria we must recognize *paralysis of the heart* outside of all toxic influence. In these cases there occurs sudden disturbance of the vagus, which may be the seat of degenerative changes. Polygraphic methods with radioscopy have been advised in the study of the phenomena induced by the toxic action of the Klebs-Löffler bacillus on the heart. The *prognosis* in postdiphtheritic paralysis after the third week is favorable, while the cardiac, pharyngeal, and diaphragmatic palsies beginning before the third week are serious. Myocardial weakness tends to supervene as a sequel. It is evidenced by the sudden accession of pallor, nausea, sometimes by vomiting, and also by weak heart sounds and a feeble, broken, irregular pulse, etc., and usually leads to a fatal termination.

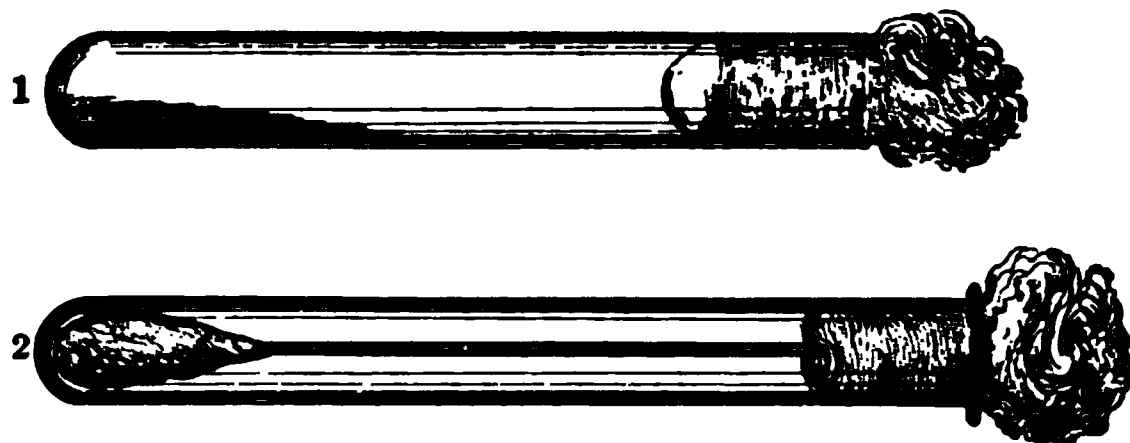


Fig. 13.—1, A tube of blood-serum; 2, a sterilized cotton swab in test-tube.

Rub the swab gently but freely against the visible exudate, and without laying it down, after withdrawing the cotton plug from the culture-tube, insert it into the latter, and rub that portion which has touched the exudate gently but thoroughly over the surface of the blood-serum without breaking its surface. Now replace the swab in its own tube, plug both tubes, and place them in the box provided by the health officials. This is to be sent to the bacteriologic expert. In laryngeal diphtheria the swab is to be passed far back and rubbed freely against the mucous membrane of the pharynx and tonsils.

The **diagnosis** of a pharyngeal diphtheria is not difficult if an epidemic be prevailing. The false membrane on the fauces and the presence of albumin in the urine give us a practically certain diagnosis. The only unequivocal evidence of the disease, however, is the finding of the Klebs-Löffler bacillus in the membrane.

An immediate recognition of the disease is often possible from a smear preparation of the exudate from the throat (Fig. 13), the Klebs-Löffler bacilli being present in sufficient numbers to be readily distinguished by the microscopist. Park, who has had a rare experience with this affection, makes the following statement: "In cases in which the disease is confined to the larynx or bronchi surprisingly accurate results can be obtained from cultures, and although, in a certain proportion of cases, no diphtheria bacilli will be found in the first, yet they will be abundantly present in later cultures. We believe, therefore, that absolute reliance for a diagnosis cannot be placed upon a single culture from the pharynx in purely laryngeal cases." When a bacteriologic examination cannot be made the practitioner must regard as suspicious all forms of throat affections in children, and carry out measures of isolation and disinfection. In this way alone can serious errors be avoided.

Differential Diagnosis.—Based on the observed fact that alcohol decolorizes diphtheria bacilli much more rapidly than the *alcohol-fast pseudo-*

diphtheria bacilli, Lauger¹ suggests this means of hastening the differentiation of the disease.

From *follicular tonsillitis* we differentiate diphtheria by the seat of the membrane, that of the former being *in* the tonsils, while diphtheritic membrane is *over* the tonsils and *over* the soft palate. Moreover, in follicular tonsillitis the fever is high, the onset is sudden, and it is usually associated with gastric disturbance. Albuminuria is generally present in diphtheria, while it is present in follicular tonsillitis in exceptional cases only. Moreover, mild cases may not present albuminuria, or fail to show the presence of albumin until later in the disease. The histories of the two cases are quite different. (For differential diagnosis between diphtheria and follicular tonsillitis, see also Table, p. 729.) In many instances of so-called diphtheroid lesions the membrane is formed only by *Streptococcus pyogenes* (*membranous angina*), and these cases are sometimes of an intense grade.

Croupous or *membranous angina* (a *streptococcus* infection) may offer some difficulty; yet in this disease there is no tendency to spread to the nasal mucous membrane or to the larynx; there is a diminished glandular enlargement; there is no albumin, and the onset is more sudden.

In *Vincent's angina* there is an absence of the formation on the surface of the mucosa of a thick false membrane; it is an ulceromembranous process. There is a deep and often wide-spread necrosis of the mucosa of the palate and tonsil. Bacteriologic examination shows the presence of a large number of atypic bacilli, which are often associated with a spirillum. According to H. W. Bruce there is an absence of the diphtheria bacillus.

Diphtheria frequently is associated with a rash, rendering it difficult to distinguish the condition from *scarlet fever*; but in diphtheria the rash is more truly an erythema, while in scarlet fever it consists of slightly raised points between which there may be an erythematous conditon. The rapid pulse of scarlatina is of assistance in the discrimination. The glandular swelling and sloughy condition of the throat, however, closely resemble diphtheria, and a positive diagnosis without a bacteriologic examination is often impossible.

Prognosis.—Formerly diphtheria was at the same time the most prevalent and most fatal of the acute infections, the mortality being 30 to 40 per cent., although variable in different epidemics. The case mortality from diphtheria has been very materially reduced since the introduction and wide use of anti-toxin—certainly over 50 per cent. The remarkable diminution in the death-rate from laryngeal diphtheria has coincided precisely with the use of anti-toxin. Of especially unfavorable prognosis are those cases that show large quantities of albumin in the urine, cervical glandular enlargement, excessive nasal discharge, rapid extension of the exudate, a necrotic membrane, vomiting, and partial or complete suppression of the urine. A sudden fall of temperature to a subnormal level and an irregular pulse or bradycardia are a bad augury. Morse's extensive observations are opposed to those of Bouchot and Dulinsay, who claim that the degree of leukocytosis is of prognostic value. Guiart and Fortineau have noticed that the long diphtheria bacilli are associated with the more virulent type of the disease. The cases of neuritis invariably recover. The child is liable to suffer from the effects of the disease for years after apparent recovery.

The *causes of death*, in their order, are as follows: membranous croup or laryngeal stenosis; septic infection, which may be a slow death; sudden heart failure—paralysis of the heart; bronchopneumonia following tracheotomy or occurring during an advanced stage.

Treatment.—**PROPHYLAXIS.**—The best preventive measures against diphtheria are a clean nose and mouth. The slightest appearance of a coryza

¹ *Münch. med. Wchnschr.*, September 19, 1916, 1373.

must be overcome at once by the use of a mild antiseptic wash; all accumulations of crusts, dust, dried blood, etc., should be removed from the nose twice daily, especially in children attending school or during the prevalence of an epidemic. The child should be early taught to employ a small antiseptic gargle as a daily routine, using a weak solution of hydrogen peroxid or the official antiseptic alkaline solution. The teeth should be carefully cleaned daily, and all decaying teeth should be filled or removed. Since domestic animals, especially cats and dogs, may communicate the disease, they should be excluded from the sick-room.

All cases of sore throat should be examined for the Klebs-Löffler bacillus, and if it is found, the individual should be isolated; and all cases of diphtheria should be kept isolated until cultures taken from the throat or nose fail to indicate the presence of the specific germ. D. M. Lewis,¹ however, states that inspection of the nasopharynx is less misleading than cultural data. "Thus, not a single case of diphtheria could be traced to infection from those in whom physical examination gave a negative, and culture a positive, result." Moreover, all persons exposed to this disease and those caring for diphtheritic patients should receive immunizing doses of antitoxin. Bacteriologic examination of the throats of school-children is of the greatest aid in controlling epidemics.

An unrecognized feature in the prophylactic treatment of the disease is seen in the uncertain period of convalescence. It frequently happens that long after all membrane has disappeared active bacilli may still cling to the throat. The persistence of the bacilli may be accounted for at times by assuming that the accessory sinuses of the nose may be involved. This condition may also continue for from two to six months and even longer in deeply fissured tonsils; and the disease may be communicated by such throats in the act of kissing young children or adults with sensitive throats or with broken buccal mucous membrane. For this reason the indiscriminate kissing of young children on the lips should be interdicted by the physician. The tincture of iodine applied to the tonsils, when bacilli are found in the throat a week after the close of an attack, is a useful means of controlling the further spread of the infection (Strauch). Miller advises formaldehyd, spraying the throat with a solution varying from $\frac{1}{4}$ to 1 per cent. of the usual 40 per cent. solution. Ruh, Miller, and Perkins found that the average duration of the carrier state was thirty-one days; they found that after tonsillectomy the average day of release was eight plus. Bell recommends the method of Schiotz and of Page, namely, the application of fresh broth cultures of the *Staphylococcus pyogenes aureus*, and also the treatment by kaolin, spraying the nose and throat every three hours with the powder, or eating $\frac{1}{4}$ dram of kaolin every hour. As the carrier in the great majority of cases harbors the organism in the tonsils, tonsillectomy is sometimes necessary before he gets rid of the bacteria. Carriers of the germs in the nose apparently in most instances have some chronic pathologic condition which is responsible for the inability to rid the nasal passages of the organism. Such cases may also require operative procedure before the focus of infection can be eradicated. As a further means of ridding carriers of the germs and of preventing patients becoming carriers Roskam reports favorable results from local treatment with insufflation of pulverized antitoxin both in convalescents and carriers. At times the bacilli persisting in the throat are non-toxic; it is therefore advisable upon attempting radical methods of eliminating the organism to determine this point. Cultures of the offending bacilli are injected intraperitoneally into a guinea-pig. Failure to kill the pig indicates the absence of virulence in the organism and, as practised in our Philadelphia Hospital for Contagious Diseases, is a sign that quarantine may be discontinued.

¹ *Jour. Amer. Med. Assoc.*, May 13, 1916, p. 1535.

Insufficient attention to isolation and disinfection of the milder cases explains the occurrence of many house epidemics. The physician must, during his visits, wear a surgeon's apron or linen duster which has been steeped in a mercuric chlorid solution and allowed to dry. His hands and face should be washed in a similar solution on leaving the room.

TREATMENT OF THE ATTACK.—The treatment falls naturally under several departments: (a) The hygienic measures to limit the diffusion of the disease; (b) the local management of the throat to destroy early the toxic germs; (c) medication to antagonize the effect of the toxins, and eventually to overcome the complications and sequelæ.

(a) **Hygienic Treatment.**—The patient should be in a room well exposed to sunlight and fresh air, and superfluous furniture and hangings should be promptly removed. Even in mild cases the patient should be kept in bed throughout the attack. White and Smith, from a study of the heart complications in 946 cases of diphtheria, believe that the presence of murmurs and a slight degree of irregularity are no contraindications to getting out of bed at the end of two weeks if the first sound is strong and the heart is not dilated. Patients who have been severely ill should be kept in bed for a longer period. The comfort of the patient is enhanced by two daily sponge-baths of alcohol and water.

Feeding.—Nursing infants may be fed on breast-milk obtained by a breast-pump, but should not be placed at the mother's breast (Holt). The rule must be to pay every possible attention to the feeding. Milk in some form being our main dependence, it should usually be diluted, and for young children partially if not wholly peptonized. The greatest difficulty comes late in the disease, when the child is septic. At this time vomiting is most easily provoked and swallowing is rendered very difficult on account of the swelling and pain. We must not neglect the feeding even if it does cause discomfort, and here forced feeding by means of gavage is most valuable. Gavage is likely to be more successful with children under three years than rectal alimentation. In older children who object to the tube through the mouth, it may be passed through the nose with little difficulty, and gavage by this route, even in intubated cases, will be extremely satisfactory. Concentrated broths, meat juice, and even milk-punch or raw eggs may be given in this way.

(b) **Medicinal.**—Since the wide-spread employment of antitoxin, medicinal measures have correspondingly decreased. Alcohol is at times indicated when there is marked prostration and weakness as evidences of severe toxemia. It may be given in divided doses, mingled with the food, in quantities sufficient to make 1 ounce (30 c.c.) in twenty-four hours. If indicated, strychnin should be employed in full doses; for a child four years old gr. $\frac{1}{30}$ (0.002) may be given every six to eight hours.

Digitalis does not hold an important place in the heart weakness of diphtheria, and yet it is strongly indicated on theoretic grounds. Clinically, it has been found to have an unfavorable action on the stomach before its good influence can be had on the heart itself. The same may be said of camphor and ammonium carbonate. The aromatic spirits of ammonia is valuable for rapid effects in syncopal attacks. In cases of threatened heart paralysis occurring late in the disease Holt has found nothing so valuable as morphin employed hypodermically, the drug being given in full doses and repeated every two hours, keeping the child under its influence for some days. In cases of diphtheria in which a murmur and slight arrhythmia develop, efforts at treatment should be concentrated on the general condition with absolute quiet. For paralysis, the sequel, the persistent use of strychnin together with rest and hematinics is recommended.

Internal medication should be minimized. Symptoms, as vomiting or diarrhea, are to be met with sufficient therapy only for their control.

(c) **Local Treatment.**—For the direct attack upon the membrane in the throat nearly all the remedies of the Pharmacopœia have been used. Gargling, swabbing, painting, spraying, and washing the throat all have their advocates.

Fig. 14.—Temperature-chart of a case of diphtheria.

Fig. 14.—Temperature-chart of a case of diphtheria.

Fig. 14.—Temperature-chart of a case of diphtheria.

Since the acceptance of the antitoxin treatment medical opinion has suffered a decided change as to the importance of local measures, so that at the present day they are perhaps too much neglected. The only object of local treatment is a more thorough cleanliness in order to offset the effects of the secondary infection, associated with the membrane formation. For this purpose mild antiseptic washes are sufficient. Examples of these include hydrogen peroxid, diluted one sixth, and used both as a gargle and spray, the official alkaline antiseptic solution, diluted one-half, and normal salt solution.

In laryngeal diphtheria the child should inhale an atmosphere laden with the vapor of slaking lime or, whenever practicable, an atmosphere saturated with Löffler's solution (menthol 10 grams, dissolved in sufficient toluol to make 36 c.c.; liq. ferri sesquichlorid, 4 c.c.; absolute alcohol, 60 c.c.). J. Cordin warmly recommends mercurial fumigation for the relief of laryngeal stenosis. The development of the signs of actual stenosis, as shown by stridulous breathing, cyanosis, etc., furnishes an indication for either intubation or tracheotomy. According to my observations the results of intubation have been quite favorable, and I would strongly recommend a trial of this procedure before resorting to tracheotomy (see temperature-chart, Fig. 14). To obviate the necessity for reintubation vapor inhalations have been successful in my hands.

(d) **External applications** to the throat have no effect on the course of the disease. They are useful, however, in relieving the pain and the swelling in the lymph-glands. Careful massage of the neck with camphorated oil, as hot as the skin will tolerate, is very soothing; and soap liniment may be used in the same way, or, if much pain exists, chloroform liniment may be substituted. Poulticing for the relief of pain is not

desirable, as it seems to favor suppuration. In older children the ice-collar has been used with good effect, and it soon brings grateful relief from the tension and subdues inflammation. Levinson recommends early lancing of suppurating glands to prevent a general septicemia. All manipulations about the child, however, should be carried on as gently as possible.

Specific Therapy; the Antitoxin Treatment.—This has now passed beyond the stage of experimentation. The general average mortality of diphtheria has been remarkably reduced by means of the antitoxin treatment. The studies of Behring, Roux, Kitasato, and others, published in 1890, have demonstrated that the use of the blood-serum of the lower animals, artificially rendered immune against diphtheria, has a powerful healing influence upon diphtheria in man. In 1892 Behring further showed that the blood of an immunized animal had the power both of protecting and of curing susceptible animals which had been inoculated either with the toxins or the bacilli of diphtheria. In preparing the blood-serum it is desirable to have a uniform strength or standard— $\frac{1}{10}$ c.c. of what Behring calls his normal serum will counteract ten times the minimum of diphtheria poison fatal for a guinea-pig weighing 300 grams; 1 c.c. of this normal serum he calls an antitoxin unit.

Dosage.—Schick and his colleagues recommend that in mild and medium cases of diphtheria (*i. e.*, in 90 per cent.) a single dose of 100 units of antitoxin per kilogram of body weight suffices, and that in the severest cases 500 units per kilogram may be injected. If this be done, repeated injections are superfluous and unwarranted, as a rule. Upon the same basis the New York Health Department recommends the following specific dosage of antitoxin units:

	Mild.	Moderate.	Severe.	Malignant.
Infants under two years (10 to 30 pounds)	2000–3000	3000– 5,000	5,000–10,000	10,000
Children under fifteen years (30 to 90 pounds)	3000–4000	4000–10,000	10,000–15,000	10,000–20,000
Adults (over 90 pounds). . . .	3000–5000	5000–10,000	10,000–20,000	15,000–40,000

They advise in mild and moderate cases that the antitoxin be given subcutaneously or intramuscularly; in severe and malignant cases one-half of the antitoxin intramuscularly and one-half intravenously. The sites to be selected for injection are various. In very young children either the buttock or thigh is to be preferred, while in older children the flanks or subscapular spaces may be chosen as well. The injections should be made deeply into the subcutaneous cellular tissue, and the swelling which results should not be rubbed. J. D. Rolleston and C. MacLeod¹ employ intramuscular injections followed by the application of iodine and a collodion scab. It is to be emphasized that the best results are obtained from early injections. In laryngeal cases intubation should be combined with the serum treatment in suitable cases. The early use of antitoxin in this disease greatly diminishes the proportion of cases in which complications occur.

In favorable cases the influence of the serum soon becomes apparent. Within twenty-four hours the faucial swelling diminishes, the membrane exfoliates, the temperature falls, the pulse becomes slower and stronger, and the general condition of the patient quickly improves. In cases of moderate severity and when injections are employed early the improvement in the throat and the constitutional symptoms is very decided; and the earlier the case comes under treatment, the better are the results. There are, however, some cases of great severity in which the antitoxin has been used early, yet has not shown any benefit. Kronig has found that incising the hard, swollen process enhances the efficiency of the diphtheria antitoxin.

¹ *Brit. Jour. Child. Dis.*, July, 1914.

A danger in serum therapy may be the development of local abscesses, which, if full antiseptic precautions be taken, must be rare indeed. I have escaped them altogether. Certain skin eruptions have been observed after injections, mostly urticarial, though sometimes scarlatiniform. The latter form has given rise to apprehensions of scarlatina. Widerhofer had one case which was isolated as measles, but never developed any symptoms other than the suggestive eruption. Rarely joint-pains and swellings, with general prostration, supervene.

Anaphylaxis.—Occasional individuals are hypersensitive to parenteral introduction of foreign protein (horse-serum, egg-white, diphtheria antitoxin, etc.). In such persons the injection of antitoxin may be followed by alarming symptoms and even death. The possibility of these anaphylactic symptoms developing should not deter the physician from using antitoxin. The condition is of extreme rarity as compared to the numerous times antitoxin is used without untoward effects, and innumerable lives will be saved by the prompt use of antitoxin where one might die from anaphylactic shock. The tendency to anaphylaxis may at times be surmised when a person gives a history of asthma, particularly of the so-called horse asthma. If the reaction occurs, atropin and adrenalin should be administered hypodermically (intramuscular) immediately and artificial respiration resorted to if necessary. Hypersensitiveness may be determined by injecting 0.1 c.c. of the serum subcuticularly. The appearance of a wheal surrounded by a red ring of capillary congestion within a few minutes of the injection shows that the patient is sensitive to horse-serum. If the possibility of an anaphylactic reaction seems probable (asthmatics, individuals who have recently been given antitoxin, presence of positive skin reaction), it has been suggested that the state of anti-anaphylaxis (resistance to a foreign protein) be developed by the injection of 0.5 c.c. of antitoxin a few hours before the principal injection is given.

Prophylactic Immunization.—For establishing immunity in subjects exposed to infection antitoxin may be given in doses of 500 to 1000 units. This will afford immunity for a period of approximately three weeks. In order to lengthen the relatively short time that passive immunization protects as produced by antitoxin, Behring proposed active immunization with diphtheria toxin combined with antitoxin. The results have been splendid. For example, in a series of 100 non-immune children controlled by the Schick test, Park and Zingher produced an immunity which lasted as long as the cases were studied—one and one-half years. Zingher in a recent report¹ advises immunization of all children between the ages of eighteen months and twelve years who are not immune as shown by the Schick test. For this purpose three doses of the toxin-antitoxin mixture of 10 c.c., each one given every seven days. The mixture should represent about 85 per cent. L + to each unit of antitoxin and should be slightly toxic. General symptoms, manifested by malaise and rise in temperature, are present in about one-fifth of the cases. Zingher and Park believe that it is advisable to immunize all young children shortly after attaining their first year, as the toxin-antitoxin mixture "starts a continual cellular production of antitoxin which would have otherwise appeared much later in life." The immunity does not develop for a few weeks after injection, so is valueless for immunization if immediate results are desired, as in the case of an epidemic.

¹ *Amer. Jour. Dis. Child.*, 1918, xvi, 83.

SEPTICEMIA

Definition.—Septicemia is a systemic infection due to a microbic invasion of the blood and tissues, with or without a detectable seat of infection. Septic toxemia is the condition with its constitutional symptoms arising as a result of the presence of bacterial toxins in the circulation from some focus of pyogenic infection. "Sapremia" is a term formerly frequently employed to indicate a poisoning with chemical products of saprophytic origin. Such a condition is no longer recognized as an entity. The word is dropping out of medical nomenclature, but is used at times synonymously with "toxemia."

Pathology.—After death the body putrefies early. The macroscopic changes in the viscera are often wanting. The muscles present a brownish color tint. The pia mater is generally congested and, together with the nerve-centers, may be the seat of ecchymoses. The blood is dark ("tar-like"); its coagulability is diminished and, microscopically, it shows micrococci and bacilli. The organisms, however, are not so constantly found in the circulating blood as in the septicemia of mice or rabbits. The spleen is somewhat softened and its lymphoid elements more distinct. Ecchymoses are found in the serous membranes.

In protracted septicemia more marked alterations exist, and among them may be briefly enumerated the following: endocarditis (rarely ulcerative); gastro-intestinal catarrh (of the duodenum and rectum in particular) with punctiform extravasations; enlargement of the lymphatics and spleen, with softening of the latter; cloudy swelling of the liver (rarely the so-called emphysema of the organ due to putrefaction); edema and catarrhal inflammation of the uriniferous tubules; congestion, sometimes associated with edema of the lungs; and inflammation of the pleura, pericardium, and peritoneum, with ecchymoses.

Microscopically, the internal organs show numerous small foci of inflammation, some of which may be the seat of "coagulation-necrosis." Bacteria are found in abundance in various situations, such as the exudations, the capillaries of the inflammatory foci, and renal glomeruli.

Etiology.—**BACTERIOLOGY.**—The causative organisms are usually from one of the streptococcic group—the *Streptococcus hemolyticus*, *S. viridans*, *S. mucosus*—but the *Staphylococcus pyogenes aureus*, *S. albus*, the pneumococcus, the gonococcus, the *Micrococcus intracellularis meningitidis*, the *Bacillus pyocyaneus*, *B. aërogenes capsulatus*, *B. proteus*, as well as many other forms and varieties of bacteria, may be responsible for the clinical picture, distinguishable as to etiology only by the blood-culture and isolation of the specific germ from the blood.

MODES OF INFECTION AND CAUSES OF INTRODUCTION OF THE MICRO-ORGANISMS INTO THE SYSTEM.—(1) **Wounds**, either surgical or the result of injury, with which we have nothing further to do in this work; gangrenous areas, cold abscesses, collections of extravasated blood or of exudates in serous cavities, localized septic processes (*e. g.* osteomyelitis, pyelitis, etc.), and similar conditions either form foci which afford splendid culture-media for bacteria, or, secondarily infected, permit the germs to break into the blood-stream, or, primarily infected, the same sequence of events may follow, particularly in an individual already weakened by the original lesion.

(2) **Through the uterus**, following labor, miscarriage, or abortion. Generally in these cases there are accompanying local changes, but in a few the poison appears to pass the unguarded portals of the organ, while the latter exhibits nothing abnormal.

(3) The cases in which the poison gains entrance into the body **without obvious wounds** or raw surfaces are relatively more common. When the skin is quite natural, septic infection cannot occur, but the slightest abrasion or cut, bed-sore, etc., may serve as a gate of admission. These slight lesions "may be almost completely healed by the time the severe symptoms of the disease are developed" (Strümpell).

(4) **Mucous membranes** often admit the virus, being less protective in nature than the skin. The numerous bacteria—benign and pathogenic—that are constantly present in the intestinal canal may also find in local lesions (as in typhoid fever, dysentery, etc.) or catarrhal inflammation even points of lodgment and cause a systemic infection.

(5) Septic manifestations often follow attacks of **tonsillitis**, and it is probable that the tonsils are frequently points of entrance for the organism.

(6) In scarlet fever, diphtheria, erysipelas, measles, and small-pox especially, and to a less degree in typhoid fever, pneumonia, tuberculosis, and syphilis a secondary streptococcic or pyogenic infection often takes place, obscuring at times the primary disorder and causing an extremely serious complication.

(7) Chronic wasting and incurable diseases are prone to terminate in pyogenic infections, the so-called terminal infections. Thus Flexner in 255 cases of chronic heart and kidney disease isolated, at autopsy, organisms in 213 of the cases. The terminal infections result in a rapid exitus in individuals who apparently have shown but little change in their chronic process. Such infections seem to come on causelessly in many cases or upon the slightest provocation.

Clinical History.—(1) **SYMPTOMS OF SEPTIC TOXEMIA.**—The more marked constitutional symptoms of the toxemia of localized infections include chilliness or chills at the onset, a moderate febrile reaction, malaise, a leukocytosis, indefinite gastro-intestinal complaints, and prostration. These symptoms are usually absent, however, and the patient suffers only from a slight malaise and indisposition.

(2) **SYMPTOMS OF SEPTICEMIA.**—There is an *incubation* period which is of variable duration, though usually averaging several days. The *onset* is gradual, although often marked by a *chill*. Accession of *fever* following surgical procedures, with headache, anorexia, prostration, sometimes vomiting and diarrhea, and especially dulness occasionally amounting to mild stupor, announce the affection; these symptoms should also excite suspicion in the absence of obvious causal factors. They become intensified, and now the attack may closely simulate certain other infectious diseases (typhoid fever, acute miliary tuberculosis, ulcerative endocarditis, etc.), the clinical picture as outlined presenting nothing characteristic. There are, however, more or less distinctive features which will be considered seriatim.

(a) **The Fever.**—This is usually of the *continued* type, and tends to increase in degree, fatal cases often terminating in hyperpyrexia. At the beginning the temperature may rise quite rapidly, and in some cases it may even be subnormal. Deep morning remissions may be observed and the initial chill may be repeated.

(b) **The Circulatory System.**—The pulse is frequent, and near the end becomes very weak. In subacute cases characteristic lesions (endocarditis in particular) may develop, but are difficult of recognition, since they do not, as a rule, give rise to audible murmurs or other physical signs. In other instances soft murmurs may be heard, but it is indeed hard to discriminate these from functional sounds. A hyperleukocytosis is observed in those cases in which there is good resistance; the extent of the leukocytosis and the poly-

morphonuclear increase serves as a prognostic index; in general, the higher the leukocytosis, with a moderate increase of polynuclears, the better is the prognosis. Anemia is always present, but becomes particularly marked in cases of septicemia caused by the hemolytic organisms. At some time or another during the course of the infection the offending organism can be demonstrated by blood-culture.

(c) **Gastro-intestinal System.**—The spleen may become perceptibly enlarged and gastro-enteritis is usually present either in an acute form with vomiting and frequent serous discharges or, more often, merely with diarrhea of moderate intensity (septic diarrhea).

(d) **Cutaneous Symptoms.**—Punctiform hemorrhages into the skin are of prime importance in the diagnosis. Occasionally more extensive ecchymoses appear, scarlatinal eruptions also showing themselves, but these are less characteristic. Among rare appearances, herpes, roseola, edematous inflammations, and faint jaundice may be observed.

(e) **Renal Symptoms.**—The lesions constitute the so-called "septic nephritis," the urine often containing a fair amount of albumin, epithelium, tube-casts, and red and white corpuscles.

Diagnosis.—Here the existence of an incubation period, the continued fever, mental apathy, faint jaundice, splenic enlargement, and the characteristics of septic nephritis all combine to form a well-defined group of phenomena. A careful blood examination should be made for micrococci, etc., and cultures should be undertaken in spontaneous septicemia and associated forms (*e. g.* septicopyemia). The surgeon should look to the condition of the wound if one is present, and if no visible focus of infection, as a wound, is discoverable the physician should make a most thorough examination in order to discover if some unsuspected lesion is responsible for the symptoms.

Course and Prognosis.—The course may be brief, virulent attacks sometimes terminating fatally within forty-eight hours, or in other cases the termination may be postponed for days or weeks. The mildest types may rarely terminate favorably, but the effects are not dependent upon the dose of organism to any great extent, but rather upon the virulence of the organism, upon the promptness with which the primary focus of infection may be cleaned out so as to prevent reinfection, and upon the individual resistance of the patient.

Treatment.—Of first importance is the removal of the cause, and small wounds should be excised and parts freely cauterized. In the present war large suppurative wounds have been most successfully treated by the antiseptic of Dakin. The physician must support the patient's strength by a suitable dietary and by the judicious use of cardiac stimulants; the former should consist mainly of liquids (milk, egg-white, meat-juice), and the latter of alcoholics, together with strychnin and ammonia. Of medicines, internal antiseptics (mercuric chlorid, creasote, etc.) deserve a trial. The fever calls for hydrotherapy. Quinin in large doses (gr. x—0.65) every four hours should be given if well tolerated by the patient. To meet the renal conditions the free use of water, together with the least irritating of the diuretics, is to be advised. A powerful agency in eliminating the micro-organisms and their toxic products is found in normal salt solution, which may be administered by hypodermoclysis ("washing the blood"). Not less than from one to several pints of this fluid are to be used daily. If the blood-pressure is persistently low, adrenalin is valuable when *slowly* administered intravenously in the proportion of 5 minims of the 1 : 1000 solution to 1 pint of warm saline solution (Sajous). Enteroclysis, using a 3 to 5 per cent. dextrose solution in tap-water, is of value in supplying the patient with additional water and nutrition. The intravenous injection of an isotonic solution of sugar is recommended.

Specific Therapy.—Unfortunately, no specific type of therapy has proved its value in the treatment of this condition. The subcutaneous injection of nucleins, for the purpose of increasing the number of circulating leukocytes, has been tried without very definite results. Vaccines are contraindicated in severe types of septicemia, but may be of value in the treatment of long-continued light cases of septicemia infected with an organism of low virulency. Antisera are of value only when given in large doses early in the course of the disease. Owing to the large number of various types and strains of bacteria that may be responsible for the infection it is impossible to prepare a specific serum from the responsible organism, as a rule, in time to be of value. In some cases in which streptococci have been isolated by blood-culture or in which it seems likely that a streptococcic infection is present—*e. g.*, puerperal septicemia—50 to 100 c.c. of a stock polyvalent streptococcic serum may be given intravenously daily until some favorable or unfavorable effect is shown.

PYEMIA—SEPTICOPYEMIA

Definition.—A septicemia invariably associated with secondary abscesses, and due to an absorption of pyogenic organisms.

Pathology.—The cadaver does not undergo putrefaction as early as in septicemia. Briefly considered, the pathologic lesions that fall within the physician's province arrange themselves under the following heads:

(1) **Thrombosis and Embolism.**—At first the veins leading to and from the seat of the local changes from which pyemia arises contain thrombi which may soften into a puriform material. Thrombi are also found in the lungs (a circulating embolus first finding lodgment in the pulmonary artery or its branches), liver, kidneys, spleen, and the cortical substance of the brain. *Fresh emboli* may be formed in the circulating blood. Suppurative phlebitis is almost constantly present.

(2) **Abscess.**—These so-called metastatic abscesses are set up by septic emboli or result from the thrombi (chiefly pulmonary and portal), and are found in the lungs, liver, spleen, and kidneys. They are not large, but may coalesce and form cavities of the size of an apple. An original focus of suppuration may be the bronchial glands. The kidneys are the chief organs of elimination in this disease, and hence it happens that numerous clumps of micrococci (*infarctions*) producing miliary abscesses are frequently seen in the regions of the malpighian bodies. There are many other, though rarer, seats of abscesses, as the muscles, submucous and subcutaneous tissues, bones, the parotid gland, ovaries, and testicles.

(3) **Lesions of the Skin and of Mucous and Serous Membranes.**—At the postmortem examination hemorrhagic extravasations and pustules are often visible in the skin. The mucous membrane of the alimentary tract is rarely affected, differing in this point from septicemia, though occasionally ulcers may be noted, and most commonly in the stomach near the pyloric orifice (in puerperal cases) and in the large bowel. Probably they are always secondary to the submucous miliary abscesses. The serous membranes (pleura, pericardium, meninges of the brain, synovial membranes) may be the seat of purulent inflammation and of hemorrhagic extravasations.

(4) **Cardiac Lesions.**—Ulcerative endocarditis forms the chief morbid lesion (*vide* Ulcerative Endocarditis). Myocardial foci of suppuration may be present.

Etiology.—Bacteriology.—The organisms responsible for this condition are those that have already been enumerated under the corresponding section upon septicemia.

Paths of Infection of the Body.—A septicemia always precedes the secondary pyemic condition, except those extremely rare cases where the bacteria break into the lymphatic system (*e. g.*, the thoracic duct). As a result of this the bacteria may reach the veins and produce a thrombophlebitis. Less frequently they reach the arteries and produce thrombo-arteritis. From the former condition emboli may be disseminated throughout the system, while from the latter the emboli are arrested in the neighboring capillaries to which the tributaries of the vessel lead.

In *pyemia*, in which there is no wound to act as an infection atrium, we must presuppose the existence of a trivial lesion. I am certain that ulcerative endocarditis is always secondary to foci of inflammation elsewhere. The appendix is often the primary or original focus in this category of cases, micrococci localizing themselves here in consequence of a preceding disturbance of the circulation or catarrhal inflammation. I recollect one case in which no original abscess was found at the postmortem.

Clinical History.—Incubation.—The disease sets in within the first week after the reception of the wound or operation. The wound looks unhealthy, and phlebitis of the efferent veins is noted.

A most conspicuous symptom, and usually the first, is the *chill*; it may, however, be preceded for a variable time by *fever* of a continued or intermittent type. The fever of pyemia is of the suppurative type. Profound *prostration* develops early; the *skin* presents an icteroid appearance, and gastrointestinal symptoms may appear, but are not prominent. The signs of abscess of the lung, liver, and other organs may develop in some cases, while in others the whole clinical picture is colored by the ill-defined characters of ulcerative endocarditis.

(a) **The Chill.**—This may be mild, though oftener it is quite severe. It is repeated throughout the course of the disease at somewhat irregular intervals, and rarely it may recur several times on the same day. Chills are most apt to occur during the daytime.

(b) **The Fever.**—A rapid rise of *temperature* accompanies the *chill*. The fever-curve is of the irregularly intermittent or profoundly remittent type, with an intervening period showing slight or marked variations, and as decided deviations may occur within a short space of time, a two-hour record should be kept. The temperature rarely falls to the normal level; it may do so, however, and remain there for one or two days. To explain the peculiarities of the curve in this disease we need only recall the great variety of pathologic processes before noted. With the sharp fall of temperature *sweating* occurs and leaves the patient more or less exhausted, though only temporarily so as a rule.

(c) **Respiratory System.**—Symptoms referable to the organs of respiration appear early. The pulmonary abscesses are usually latent, but may give rise to dyspnea, cough, and occasionally a purulent expectoration. *Pain* is present if they are superficially located, and under such circumstances the physical signs of cavity or of pleural effusion may be noted. The signs of *pneumonia* at one or both bases may also develop, the expectoration now becoming rusty.

(d) **Splenic and Hepatic Symptoms.**—The foci of suppuration in the liver are difficult of recognition unless they become large as the result of coalescence and are superficially located (see article Hepatic Abscess). Splenic infarction may also be safely diagnosed if there are pain and great tenderness (due to localized peritonitis) in the left hypochondrium, with progressive enlargement

of the organ. In one case I detected distinctly crepitant sounds over the site of the spleen during life.

(e) **Cardiovascular Symptoms.**—The *pulse* at first is accelerated, but moderately full and regular; later it becomes feeble, rapid (running), or even uncountable. Frequently cases in which ulcerative endocarditis develops are apparently of spontaneous origin. (*Vide* Endocarditis in the section on Diseases of the Heart.) Among the blood appearances during life are *leukocytosis* and a rather marked reduction in the red corpuscles, with moderate poikilocytosis. Iodophilia is a frequent finding. Nucleated erythrocytes may be present. The blood-plaques are increased. Purulent pericarditis may occur.

(f) **Cutaneous Symptoms.**—The most prominent is a mild yet decided grade of *jaundice*, hemolytic in nature. Sweating has already been alluded to as a symptom, both during and after the febrile paroxysms. The skin finally shrinks from emaciation. *Skin eruptions* are common, particularly erythema, purpura, pustules, pallor, and the general surface is often decidedly *hyperesthetic*.

(g) **Genito-urinary Symptoms.**—The urine is concentrated and urates are copiously deposited. There is *albuminuria*, which may be due to the pathologic changes or may be ascribable to the fever. The microscope discloses the presence of tube-casts, micrococci, pus, and (more rarely) blood-corpuscles. Ophüls¹ describes three types of glomerulonephritis occurring in general sepsis due to streptococci, and more rarely other bacteria, namely, the acute, the sub-acute, and the chronic form.

(h) **Nervous Symptoms.**—The mind generally remains unclouded until an advanced stage is reached; then delirium sets in and is followed by a terminal coma. Metastatic purulent meningitis, with its usual symptoms (hemiplegia, strabismus, ptosis, deafness, etc.), may appear.

(i) Symptoms may be presented by the **joints and bones**. Metastatic arthritis, usually suppurative, is a not unusual concomitant, and in some cases it is combined with similar involvement of the long bones. An acute osteomyelitis may be the only ascertainable source of the pyemia.

DIFFERENTIAL DIAGNOSIS.—The disease is often confounded with malarial intermittent fever (*vide* p. 344), *acute miliary tuberculosis*, *malignant endocarditis*, and, more rarely, *typhoid fever*. Malignant endocarditis, the secondary condition, is, however, pyemic in nature. Typhoid fever is distinguishable by the Widal reaction, characteristic eruption, and course.

Prognosis.—Pyemia may kill after an illness lasting but a few days. On the other hand, it may become more or less protracted, so that a chronic form has been distinguished. In this variety the symptoms are milder in character, and recovery may rarely ensue.

Treatment.—So far as the physician's province extends, the treatment is identical with that of septicemia. For the sweating the best agents are aromatic sulphuric acid and atropin; the latter may be given with agaricin (atropin, gr. $\frac{1}{12}$ —0.0005; agaricin, gr. $\frac{1}{8}$ to $\frac{1}{4}$ —0.008–0.016) at bedtime.

FOCAL SEPSIS

The subject of the relation of septic foci to secondary systemic infection is one that is engaging the attention of the profession to an unusual degree at the present day. Among the noteworthy early contributions to the subject were those of Miller, Hartzell, Rosenow, and Billings, and his associates. The seats of these foci are various, although in the majority of cases they are found in the mouth (*e. g.*, teeth roots), the tonsils, and sinuses. The forms of oral

¹ *Jour. Amer. Med. Assoc.*, October 13, 1917, p. 1223.

sepsis principally concerned in the origin of disease in the digestive apparatus are as follows: (1) alveolar infections secondary to disease of the dental pulp and (2) gingivitis, pyorrhea alveolaris, and infections about impacted teeth and unerupted teeth (Barker).

The principal organisms met with are the *Streptococcus rheumaticus*, *S. hemolyans*, *S. mucosus*, *S. viridans*, *Entamoeba buccalis* (Smith and Barret),¹ and others.

The list of complaints caused by the absorption of toxins from these local foci is one of great length and includes endocarditis, myocarditis, pericarditis, arthritis, arthritis deformans, gastritis and gastro-enteritis, "a toxic hepatopathy" (Barker), appendicitis, cholecystitis, neuritis, nephritis, and furunculosis.

Diagnosis.—Before attributing any of the above-named conditions to a chronic septic focus, clear and convincing scientific evidence of their existence must be present, and the physician must also, by a process of exclusion, eliminate all other causes of systemic infection. The study of a suspected case often requires the services of a competent nose and throat specialist, and of an expert roentgenologist should the indications point to either sinusitis or involvement of teeth. Rosenow² holds that pulpless teeth and blind abscesses are to be regarded as the most dangerous forms of dental sepsis. Chronic septic foci are often exceedingly difficult to discover.

It is to be recollected that in many systemic infections, of which chronic infectious foci may be the apparent cause in the particular case—*e. g.*, chronic nephritis, arterial fibrosis, myocardial degeneration, and arthritis—other factors, as heredity, occupation, intemperance in eating and drinking, syphilis and gout, and the like, may play an important etiologic rôle. A chronic infectious focus may at times remain latent for a long period, hence may have no etiologic significance.

It is also of diagnostic advantage to associate the grouping of septic features in the particular case with chronic septic foci in certain organs. For example, the primary infectious focus in chronic arthritis deformans, acute rheumatic fever, chorea, endocarditis, peptic ulcer, appendicitis, myositis, myocarditis, and glomerulonephritis may be located in the head in the guise of tooth-root disease (periapical abscesses), sinusitis, and acute or chronic tonsillitis. Baude³ insists that with enlarged cervical glands the primary lesion should be sought in the teeth before incriminating the tubercle bacillus.

In cases of suspected gonorrheal arthritis an examination of the genito-urinary tract should reveal the focal point. Acute tuberculosis points to chronic foci in the lungs or thoracic lymph-glands. The clue given by the character of the disease, however, may fail to reveal the focus on painstaking thorough investigation in the supposed location. "The failure to find a focus in the expected situation should indicate an extension of the field of examination until it shall have been found" (Billings).

An assured diagnosis especially demands the discovery of one or other of the varieties of the streptococci mentioned above by microscopic and cultural methods.

In cases in which the physician suspects mouth sepsis a dentist specially trained in the diagnosis of this condition should be consulted before a judgment is formed. Such cases also demand that a roentgenogram be furnished as a diagnostic aid, but treatment based on such studies alone is unwise. Says Barker, "Any person who has devitalized teeth in his mouth does well to have them roentgenographed at intervals in order that a developing proliferative periodontitis shall not be overlooked."

Treatment.—An accurate diagnosis of chronic septic foci based on the

¹ *Jour. Amer. Med. Assoc.*, 1914, lxiii, 1746.

² E. C. Rosenow, *Jour. Dental Research*, I, 205, September, 1919.

³ *Paris méd.*, March 9, 1918, p. 199.

broad and secure ground of general pathology will alone save the profession from the invasion of recklessness in the removal of teeth, tonsils, and other organs. In all cases of secondary systemic infection our present-day view of treatment demands the removal of the focus or foci on which they depend. A cure or permanent improvement is not possible by pursuing any other course, but it is to be recollected that in a certain percentage of instances there are multiple scattered foci, and in such, unless they be found and removed, failure to relieve the systemic infection is to be expected. The subsequent treatment is, for the most part, hygienic, including an easily digestible, generous diet. Autogenous vaccines have also been used with excellent results after the removal of the causative local foci.

ACUTE ARTICULAR RHEUMATISM

(*Rheumatic Fever*)

Definition.—An acute febrile disease probably due to the *Micrococcus rheumaticus*. It is a general infection, the commonest seat of the principal lesion being the joints, “but also involving the heart, both endocardium, pericardium and muscle, occasionally the meninges and other structures” (Webster).

Pathology.—The disease does not show peculiar lesions, and, although the joints are the chief seats of invasion, still in many instances and even in aggravated cases the changes presented are slight or altogether wanting. Usually the synovial membranes of the affected joints are injected and swollen, and their surfaces may be more or less coated with fibrin. The effusion, which in a majority of instances has been found sterile, is mainly serous, but contains fibrin and often leukocytes, and occupies the joints. A similar exudate infiltrates the periarticular tissues. The tendinous sheaths may also be inflamed; the cartilages in protracted cases may become eroded, and rarely a purulent exudate may be seen.

Fatal cases, except when death is due to hyperpyrexia, usually show the changes peculiar to endocarditis, pericarditis, or myocarditis, and less frequently those of pneumonia, meningitis, or pleuritis. The fibrin factors of the blood are augmented.

Etiology.—**Bacteriology.**—Numerous investigators have attempted to isolate the causative organism, so that many types of bacteria have been described in the past as the specific agent. The results have, however, not been conclusive and are unconfirmed. From more recent work it would seem that the organism described by Poynton and Paine, the *Micrococcus rheumaticus*, may be considered as the etiological cause. It has by no means been proved that this is the true organism, but weight of evidence seems to indicate that it is. Meyer, Walker and Beaton, and others have confirmed the work of Poynton and Paine. Rosenow claims that the organism is merely a streptococcus so transmuted that it has a special affinity for the joints and heart.

Predisposing Causes.—(1) An *infective lesion* that has preceded the appearance of the articular manifestations may often be found, and this may be conceived to form a portal of entry for micro-organisms (Sacaze). The frequency with which an attack of tonsillitis precedes the development of acute articular rheumatism indicates a very direct pathological relation between the two diseases (Cheadle, Wade, Gerhardt, Packard). Preceding or accompanying the attack an infectious sore throat was noticed in 53 of 288 cases. Brodzki¹ noted 10 per cent. of cases following 610 instances of tonsillitis. (2) **Seasons.**—The months of February, March, and April furnish the largest

¹ *Berl. Klin. Wchnschr.*, April 17, 1916.

percentage of cases, though the disease is also quite prevalent in the remaining cold months; on the other hand, the disease may sometimes prevail in summer. (3) "Catching cold" was formerly classed among exciting causes, but abrupt changes of temperature merely predispose to the disease. (4) *Climate*.—Rheumatism is most prevalent in temperate latitudes. It is essentially an urban disease (Poynton). (5) *Occupation* is of importance, especially if it entail oft-repeated or prolonged exposure to the influence of wet and cold or to severe changes of temperature. Hence those who follow certain vocations are attacked with great frequency—*e. g.*, coachman, laborers, sailors, and servant-girls. (6) *Age*.—Primary attacks are most common from fifteen to thirty-five years of age. Out of 655 cases, 80 per cent. occurred between the twentieth and fortieth years (Whipham). Cases are also rather numerous between ten and fifteen years, and I have met with 4 under the former age. Sucklings rarely suffer. (7) *Sex*.—Acute articular rheumatism is somewhat more common in men than in women, possibly owing to the fact that the former sex more often follows predisposing occupations. (8) *Hereditary influence* plays a causative rôle (in 26 of 100 consecutive cases—Poynton, Agassiz, and Taylor). (9) Conditions of ill health, particularly digestive and hepatic disturbances, seem to exert a slight effect. (10) *Chronic endocarditis* renders its victims very prone to attacks of acute articular rheumatism, and some contend that the two diseases are etiologically one and the same. (11) *Choreic children* often develop rheumatism. Batton analyzed 115 cases; he found that within three years 11.3 per cent. of the children developed the disease, and after five years this total was increased to 20 per cent. (12) *Endemic and Epidemic Influence*.—In certain localities the disease is endemic, and epidemic incidence has been noted by McClymont, Newsholme, and others. House epidemics have also been observed.

An attack of acute articular rheumatism is not protective in character, but increases susceptibility. Of 288 cases, 45 per cent. of the patients had had one or more previous attacks (Thüs). In this respect the disease resembles certain other infections (pneumonia, erysipelas).

Clinical History.—Of the **incubation period** nothing is known, though *prodromata*, both local and general, may be observed. There may be malaise, slight fever, angina, laryngitis, etc., lasting from a few hours to a day or two. The *invasion* is usually abrupt, with fever and synovitis, affecting one or (oftener) several joints, and a chill or a series of chilly sensations may accompany or precede the rise of temperature. The involved joints are tender, often red and swollen, and exhibit the local signs of a rapidly developed inflammation. *Pain* is a most prominent symptom. The medium-sized or larger *joints* (knee, ankle, and wrist) are first involved, and especially those of the inferior extremities; next the shoulder-, elbow-, and hip-joints; and lastly the fingers, toes, and intervertebral articulations. One of the chief peculiarities of the disease is the fact that the joints affected are not all the seat of anatomic changes simultaneously, but that the process migrates from one joint to another from day to day, and often crosses from one side of the body to the other. Sometimes this occurs at longer intervals. Hence the number of joints involved at one and the same time may be either few or many.

In cases of average severity the general features are subordinate to the local symptoms. The fever is usually moderate, the temperature not exceeding 103° F. (39.4° C.), and the temperature-curve is of the irregularly remittent type, corresponding in severity with the joint symptoms. Defervescence is by *lysis*. The skin is bathed in a copious perspiration which is not dependent upon a previous fall of temperature. Nervous symptoms are rarely observed.

The *general course* of the disease exhibits wide variations, both as to duration

and intensity of symptoms, especially in children. It may not outlast several days, appearing with mild symptoms; on the other hand, cases sometimes persist for six to eight weeks. The latter instances are apt to show brief non-febrile periods, alternated with marked paroxysms, and similar cycles may be repeated. When the symptoms are distinct from the start the course may be briefer than when the features are of mild character. As will be seen hereafter, the disease frequently manifests complications, especially cardiac.

LEADING SYMPTOMS AND COMPLICATIONS IN DETAIL.—(1) Joints and Surrounding Structures.—As I have stated, pain is much complained of, and is greatly augmented by motion and by pressure of any sort. It may be out of all proportion to the degree of the anatomic changes. The joints affected are generally swollen (most markedly in the knees), and the swelling is due partly to effusion into the joint and partly to inflammatory edema of the periarticular structures. The sheaths of the tendons, the bursæ, and often the adjacent muscles and fasciæ exhibit inflammatory changes; hence it is usual to see an extension of the swelling for a variable distance from the joint, the backs of the hands often showing this to a marked extent. The skin may present a pink or rose-colored blush over circumscribed areas or taking the form of streaks.

In even *mild cases* there are usually two, three, or more joints involved, though it often happens that one bears the brunt of the disease, little complaint being made of others less severely implicated. Hence it should be a golden rule to examine carefully all the joints at each visit. Involvement of a single articulation (*monarticular rheumatism*) does sometimes occur, but the diagnosis of these cases offers great difficulties. On the other hand, an existing poly-articular rheumatism may become centered in a single joint and there linger with great obstinacy.

In *severe cases* numerous joints may be invaded, with an involvement of the joints of the symphyses, of the jaw, of the ribs, and the sternoclavicular articulations. Under these circumstances the patient assumes a dorsal decubitus, and seeks to relieve his excruciating pain by holding his limbs in a semiflexed position and absolutely motionless. If now an attempt be made to change his posture, he complains piteously of darting pains in the affected joints. The *fugacity* of rheumatic arthritis has already been alluded to.

The inflammation, however intense, may quickly subside in one joint, while at the same time an acute disturbance appears in another. Usually resolution is complete, no trace being left of former inflammation, though the disease may recur in the joints primarily involved. Suppurative arthritis may supervene, though rarely, and its occurrence points indisputably to mixed infection. This complication may lead to ankylosis—a sequel which does not belong to pure rheumatism.

(2) The Cardiovascular Symptoms.—The *pulse* is quickened to 100 beats per minute or over, but is soft and full, and when complications arise it shows special characteristics which are described in appropriate sections of this work. In rare instances it is very rapid, feeble, and irregular apart from cardiac involvement. The results of a careful blood-count show a high grade of *symptomatic anemia*, which may develop with marvelous suddenness. Moderate *leukocytosis* is also present. The *Micrococcus rheumaticus* may be isolated from the blood by means of appropriate bacteriological technic.

Great importance attaches to the *cardiac affections* that so frequently accompany this disease. They may arise in any case, even the mildest, or at any stage of the disease, and hence the conscientious physician cannot afford to neglect the matter of closely and regularly examining the heart. It must be recollected that no special symptoms announce the development of cardiac disease. At first we may note an increase in the febrile movement, more or

less palpitation, sometimes dyspnea, and precordial pains, which often do not amount to more than a sense of soreness. There may also be attacks of angina pectoris of apparently purely nervous origin (Strumpell).

(a) The most frequent cardiac manifestation is *acute endocarditis*, which is present in 25 to 30 per cent. of the cases. We are, however, sadly in need of reliable statistics upon this point. It usually takes the form of simple (verru-cose) endocarditis, and affects most frequently the mitral valves. But though usually indicated by an apical systolic murmur, it is hard indeed to eliminate the functional murmurs that may also develop in the course of this disease. Unless combined with the symptoms detailed above, the presence of a blowing systolic murmur does not afford trustworthy evidence of the existence of acute endocarditis. I have witnessed two instances in which endocarditis preceded the arthritic manifestations. Church and Cheadle¹ state that "in a large majority of cases, if no endocardial murmur is present during the first ten days of an attack, the endocardium escapes." While it rarely endangers life and may leave no trace, in the majority of instances the acute endocarditis does not undergo complete resolution, but leads to sclerotic changes and terminates in incurable chronic valvular disease.

(b) Next in the order of frequency is *pericarditis*, which may or may not be combined with the former. In many cases the effusion consists of organizable lymph (often large in amount); less commonly it is serofibrinous and rarely becomes purulent or blood stained. It is distinguished by its pathognomonic friction-sound, though also by other characteristic signs (*vide Pericarditis*).

(c) *Myocarditis* is often present to a slight extent in rheumatic endocarditis and pericarditis when these occur independently of each other, but to a more marked degree when endopericarditis exists. Hence it is less common than either endocarditis or pericarditis. The changes and symptoms occasioned will be discussed under Myocarditis. Here it should be pointed out that the condition weakens the cardiac walls and leads to dilatation of the ventricles. Lees holds that dilatation of the left ventricle (greater or less) is always present and one of the earliest symptoms. Aschoff's nodules in the myocardium signify a previous rheumatic infection.

If we consider rheumatism an infectious malady we can readily understand why the local manifestations should appear not only at the different articulations, but also in the cardiac structures and other viscera.

(3) **The Skin.**—Rheumatism produces copious *perspiration* which emits a sour odor. The temperature-curve in most cases is not materially influenced by the sweats. Occasionally the drops in temperature and the free sweats are concurrent, but the latter symptom is apt to persist despite the oscillations in the temperature. *Sudamina* appear, often in extensive crops. Among other *skin eruptions* less frequently observed are forms of erythema (especially *erythema nodosum*) and urticaria, which latter may be associated with purpura (*urticaria hæmorrhagica*). The association of the latter condition with poly-arthritis is known as *peliosis rheumatica*, though, according to some writers, this is not rheumatic in nature. Cutaneous ecchymoses and even extensive hemorrhages into the skin and from the mucous membranes—a general hemorrhagic diathesis—may also be encountered.

Subcutaneous Rheumatic Nodules.—In 1881 Barlow and Warner called attention to the fact that during and after acute articular rheumatism, particularly in children and young adults, small subcutaneous nodosities attached to the tendons and fasciæ may in exceptional instances be observed. These small nodules are rather firm, movable, and usually painless. The skin over them is simply elevated, with no traces of inflammatory action. They are

¹ *Allbutt's System of Medicine*, vol. iv, p. 15.

most frequently found at certain points of election (fingers, wrists, edge of the patella, malleoli, and over the back of the elbow), though also seen less frequently elsewhere; they may disappear and after a brief interval reappear. On *microscopic examination* it is seen that round and spindle-shaped cells enter into their composition. Riess believes them to be of embolic origin. I met with one fatal case of the sort which occurred in a male aged forty-two years, in which acute articular rheumatism was also complicated with endopericarditis and pneumonia. Most of the nodosities were of the size of a bitter almond. Cheadle considers that the eruption of large nodules signifies persistent and uncontrollable cardiac disease.

(4) **The Fever.**—The fact that the fever fluctuates materially in this affection has already been noted. It remains to be pointed out that if suppuration occur as a complication, the fever may be of the hectic variety; also that rarely hyperpyrexia is suddenly developed, and with it marked cerebral symptoms (restlessness, delirium, and sometimes convulsions, finally merging into stupor) are, as a rule, though not necessarily, associated. This serious condition commonly develops about the beginning of the second week. In my case cited above it began on the sixth day. Delirium usually comes on either shortly before or after the acute development of the *hyperpyrexia*. The pulse becomes excessively rapid and feeble and physical prostration extreme. The temperature may rise rapidly with slight interruptions until it touches 108° or 109° F. (42.7° C.), and as the fever reaches its maximum death usually ensues. The temperature may continue to rise after death. The cause of “hyperpyretic rheumatism” is not definitely known. It has been claimed that the intemperate are most apt to be attacked, but this belief is not corroborated by many clinicians. In a case of my own, however, in which pericarditis with hyperpyrexia occurred, the patient was an “alcoholic.” The symptoms are probably due to an intense concentration of the poison upon the nerve-, and especially upon the thermal, centers.

(5) **The Muscular and Nervous Symptoms.**—It has been stated that the adjacent muscles and fasciæ may exhibit inflammatory changes. They may also show more or less swelling, and are often very tender to the touch, while in long-continued cases muscular atrophy ensues. The cause of this change is not clear, but the most likely view is that it results not so much from disuse of the muscles (the old theory), as from some trophic disturbance due either to the arthritis, or peripheral neuritis, or, to some extent at least, from extension of the rheumatic inflammation from the nearest articulation.

Mention has been made of the grave *nervous symptoms* that are attendant upon hyperpyrexia, but, independently of the latter condition, nervous phenomena may be present. There may be restlessness and sleeplessness (due to pain), but active delirium is exceptional in uncomplicated cases, and it is usually associated with a temperature of 104° F. (40° C.) or higher. In adynamic types, which are rare, low muttering delirium merging into stupor, and even coma, may be observed. Active mental symptoms are sometimes due to cerebral embolism secondary to acute endocarditis. When pericarditis is a complication, wild delirium, with or without hyperpyrexia, or the low muttering variety with stupor, is not unusual. The drunkard may develop *delirium tremens*. *Coma*, leading quickly to a fatal result, may develop without other previous or associated nervous symptoms, and Da Costa has reported cases in which a fatal coma was probably due to uremia. Rarely coma develops during the period of convalescence. *Convulsions* may be noted generally preceding the coma, though rarely as an independent symptom. *Melancholia* may arise in the course of the disease, but more frequently at its close. *Meningitis* must be numbered among the rarest of complications.

Chorea is a not infrequent sequel of this disease in children, and more rarely

is associated with it. Of 554 cases analyzed by Osler, in only 88 were chorea and rheumatism associated. These instances may or may not be accompanied by acute endocarditis.

(6) **Pulmonary Symptoms.**—*Pleurisy* occurs, and may be excited by an extension of inflammation from the pericardium. The inflammatory process may be propagated through the diaphragm to the peritoneum. *Bronchitis* is sometimes present, but is rarely a part of the morbid process; it is secondary, and is often occasioned by the factors that are at work in every disease in which enforced recumbency and great prostration coexist. *Bronchopneumonia* may be produced. *Lobar pneumonia* rarely occurs, and is confined to aggravated cases, but pulmonary congestion is occasionally seen, and may prove fatal. Pulmonary complications develop secondary to pericarditis, and especially to endopericarditis.

(7) **The Renal Symptoms.**—The *urine* is diminished in amount, is high colored, and of high acidity and density. The standing specimen deposits urates. As in other infectious diseases, there is commonly present a slight febrile albuminuria, but acute nephritis is extremely rare. The chlorids are sometimes diminished, but rarely absent.

(8) The **spleen** is slightly enlarged in some cases.

(9) Inflammation of the *parotid gland* (rheumatic) was met with in 3 cases by Courtois-Suffit and Beaufume. The *saliva* often has an acid reaction.

(10) Rheumatic *iritis*, due to lodgment of organisms in the fine capillaries of the iris, has been observed.

CLINICAL PECULIARITIES OF ACUTE ARTICULAR RHEUMATISM IN CHILDREN.

—The arthritic symptoms in children are in abeyance, while endocarditis and pericarditis are predominant, and may appear before the joint lesions are observed. Endocarditis follows the joint lesions twice as frequently in children as in adults. Parsons lays stress upon reduplication of the cardiac second sound, audible at the apex only, as an indication of the development of endocarditis. This sign is to be distinguished from reduplication heard at the base—*e. g.*, in Bright's disease. Rheumatic tonsillitis is common, and may precede, accompany, or follow attacks of rheumatism. Erythema is a frequent concomitant, and is often mistaken for scarlatina. The febrile movement is brief and hyperpyrexia less frequent than in the adult. The nervous features are more marked, notably chorea, which Poynton has emphasized as a symptom. Out of 217 cases of chorea he found obvious heart disease in 122. Bareno reports an instance in a newborn infant.

Diagnosis.—The acute development as a primary affection of polyarthritis with fever, early tonsillitis, sudden anemia, moderate leukocytosis, and fresh cardiac murmurs, is a symptom-complex on which an assured diagnosis can be usually based.

DIFFERENTIAL DIAGNOSIS.—*Pyemia* must be carefully separated. In pyemia, however, the general condition is graver, fever precedes the local manifestations, and the fever-curve is irregularly intermitting. Rigors also occur in pyemia at varying intervals, accompanied by a steep elevation of temperature—symptoms that are absent in rheumatism. Again, suppurative processes in the various viscera and skin and slight jaundice appear in pyemia. Rheumatic symptoms fluctuate greatly, while the pyemic do not.

The multiple swelling of the joints which develops after childbirth is to be regarded as *septic* in nature. In these cases arthritis leads rapidly to suppuration, with more or less destruction of the joints. *Gout* will be distinguished from rheumatism in connection with the consideration of the former disease (*vide p. 422*).

Monarticular rheumatism is with difficulty differentiated from a group of affections which simulate it closely. (1) The so-called *gonorrheal rheumatism*

often affects a single joint, especially the knee; but in this disease there is usually a definite history of recent infection, and the local features (pain, swelling, etc.), unlike true rheumatism, are far more pronounced than the general. The course of gonorrheal arthritis is longer in duration, and is generally connected only with a single joint from the start; while acute articular rheumatism almost always begins as a polyarthritis, with subsequent fixation in one articulation. Cardiac complications are rare in the former disease.

(2) *Acute osteomyelitis* is generally single, and is sometimes mistaken for rheumatism, from which it differs, however, in the localization of the lesions in a single joint from the start, the greater prominence of the local symptoms, and in the implication of the epiphyses and the shaft of the affected bone rather than the joint, and in the graver general symptoms from the time of onset.

(3) There is a liability to mistake the *acute arthritis* of infants for rheumatism. This attacks by preference the hip or knee, and is purulent inflammation due to pyemia (Townsend), hence having no relation to the disease under consideration.

(4) *Tuberculous arthritis*, particularly in children, has been confounded with rheumatic monarthritis. The former is less indurating, the swelling presented is less symmetric, the pain is greatest in the joint itself, and the course is far less acute than that of the latter.

(5) In the course of the *hemorrhagic diseases*, scurvy, purpura, and hemophilia, effusion into the joints, either hemorrhagic or serous in nature, occurs with great frequency and is associated with rheumatic pains. The differential diagnosis rests upon the tendency to hemorrhage, and in scurvy on the lesions of the gums. The absence of fever is usually decisive; unfortunately, it may be present in these joint affections.

(6) *Glanders*, at the onset, may be mistaken for rheumatism.

Prognosis.—Recovery is the general rule. As in other infectious diseases, the chief danger springs from the great intensity of the type of infection, as manifested in hyperpyrexia with grave nervous symptoms, the development of the general hemorrhagic diathesis, etc.—happily rare occurrences in this disease. Certain complications, such as pericarditis, endopericarditis (especially common in childhood), pneumonia, etc., may render rheumatism grave or even hopeless, and rarely the endocarditis that complicates the disease is of the ulcerative variety and leads to fatal pyemia. Pulmonary embolism may occur and cause death.

The influence of personal factors may impede recovery, such as intemperate habits, great obesity, the existence of previous organic disease of the heart, or Bright's disease, etc.

Treatment.—(1) **Sanitary Environment, Diet, and Stimulants.**—The sick-room should be well ventilated, and its temperature maintained at 65° to 70° F. (18.3°–21° C.), but drafts should be avoided. The patient should be lightly dressed in flannels and covered with a sheet of the same material. The *diet* should be liquid and nourishing, milk being the best food article. Farinaceous matter, milk and Seltzer water, buttermilk, or egg-white may be employed if milk cannot be taken in adequate amount. I begin the use of easily digested proteins soon after defervescence has occurred, but have immediate recourse to the earlier liquid or soft diet upon the return of pain and fever. An ordinary dietary is to be gradually resumed. *Stimulants* may be employed if indications for their use are present. The prompt treatment of tonsillitis among children and young adults is important prophylactically.

(2) **Internal Therapeutics.**—The bowels should be opened early with calomel, followed by salines. There has been of late a surprising unanimity among clinicians in commending the use of the salicylates in the treatment

of this disease—more so than at any previous time since their introduction. They are employed in most of the larger hospitals both in Europe and America. Differences, however, relating to the mode of administration and the particular salt to be selected still exist. Wood favors ammonium salicylate, for the reasons that it is freely soluble, is rapidly absorbed, and when given in sufficient amount quickly produces the symptoms that mark salicylic action, while, in addition, it is less depressing than the other salts of salicylic acid. It is best given in milk and is usually well borne. My experience with this salt in acute articular rheumatism, though as yet somewhat limited, has been satisfactory. Until the present time sodium salicylate has met with more general favor than any other single salt of salicylic acid. The pure acid is also used, though not to any great extent at the present day. The amount given in twenty-four hours should not exceed 2 drams (8.0), while often $1\frac{1}{2}$ drams (6.0) of the sodium or ammonium salicylate is sufficient. My method is to give gr. x (0.6) every two hours during the first day, or until the pain or other local features have largely disappeared; then the remedy is given at longer intervals, but not omitted entirely. If it be given in solution with an excess of alkali it is least irritating to the gastric mucosa. The following stock prescription is one of therapeutic importance in rheumatism:

R. Sodii salicylatis, 3iv (16.0);
Sodii bicarbonatis, 3ij (8.0);
Aquæ menthæ pip., q. s. ad f3vj (180.0).—M.

Sig. Tablespoonful in water every three hours until relief of pain.

In this manner fresh exacerbations are most probably averted. If the latter occur, however, larger doses must be instituted so as to cut them short. Some recommend that the medicine be stopped as soon as the pain has been controlled. The hypodermic method of giving salicylates will prove of advantage in those patients who cannot take them by mouth. Lassere recommends methyl salicylate to relieve the pain. Some prefer salol to either the pure acid or the salicylates; in my experience, however, the use of this drug has not been followed by good results. Doubtless the reason for this lies in the fact that salicylic acid can neither be introduced into the system in sufficient amount nor rapidly enough in the form of salol.

Kinnicutt has recommended the employment of the oil of wintergreen, a salicylic compound which does not generally produce the unpleasant toxic symptoms so apt to be excited by the salicylates or salicylic acid. The dose is mx-xx (0.60–1.25), given in capsules or in milk, to be repeated every two hours. Sodium salicylate enemata ($3j-4.0$ —of the salicylate and $\text{mx}-0.6$ —of the tincture of opium in each injection) may be of advantage in certain cases. The remedy is slowly absorbed from the rectal mucosa.

The treatment with the salicylates or salicylic acid mitigates the fever, relieves the pain, and shortens the stay in bed by a few days, but does not curtail convalescence. The statistics of Williams go to show that the salicylic treatment also tends to protect against the development of cardiac complications, though it does not seem to influence the course of the complications once they are established. In my experience the alkaline treatment operates to obviate the occurrence of the heart complications and shortens the period of convalescence, but exerts slight if any influence upon the fever-curve and pain. These facts led me long since to use, in addition to salicylates, an alkaline remedy, such as sodium bicarbonate, potassium citrate, etc., in sufficient doses to render, and then maintain, the urine of slightly alkaline reaction.

Considerable discussion has arisen at various times as to the relative efficacy of the synthetic and natural preparations of salicylic acid. An effective

clinical test was carried out under the auspices of the American Medical Association. The conclusion was reached that there is no essential difference between the two preparations.

Fantoni says that mercury in minute doses (from 1 to 5 mg.—gr. $\frac{1}{80}$ — $\frac{1}{4}$, injected intravenously) will accomplish the transformation of the blood-serum into a polyvalent vaccine, thus inducing immunity.

Of interest is the recent work that has been done in acute arthritis with the intravenous injection of foreign protein.¹ Proteose, peptones, and other proteins of a similar nature were employed at first, but recently non-specific bacterial vaccines have been employed. The effect seems to depend upon the reaction, and in a general way it may be said that the more severe the constitutional reaction, the better the result. A reaction consists in a sharp rise in fever, increased leukocytosis, a chill, severe headache, and prostration occurring a short time after the injection. The employment of this method of treatment requires a considerable amount of skilled care and is not altogether safe. It is, therefore, not recommended as a therapeutic procedure outside of a hospital. Wolf,² who claims to be the first to have introduced this method of proteosotherapy into general use, says that it is advisable to avoid the severe reactions, and that equally good reactions may be obtained by the mild reactions, which he terms the "peptone effect." To secure this result it is essential that the injection be given exceedingly slowly and with especial attention paid to the patient's pulse-rate. If this becomes very rapid it is the signal to slow down the rate of injection or stop it altogether. After the lapse of a half hour to two hours the patient has a rigor, followed by a drop in temperature, and an improvement in the subjective and objective symptoms.

There are a few other remedies that should be referred to, and, although more or less serviceable, they are without specific influence. Among these is antipyrin, but safer and equally efficacious remedies have replaced this drug. Potassium iodid and the preparations of colchicum belong to this category; their effects are most beneficial in cases that drag on after the acute stage is over. Good results have been reported from the use of aspirin (gr. vii—xv—0.46—1.0 thrice daily) in both acute and chronic rheumatism. Stengel has noted improvement from the use of antistreptococcic serum in 3 cases of protracted recurring rheumatism. Menzer has successfully treated a number of cases with a serum made from streptococci of human origin. It is also indicated in cases showing a pyemic temperature (Chipman). Wolverton advises a mixed streptococcus and staphylococcus (*aureus* and *albus*) vaccine.

(3) **Local Measures.**—These occupy a subordinate place in the management of acute articular rheumatism. Their number is legion, but only a few of the more valuable can be adduced here. In mild cases the affected joints should be wrapped in cotton batting or in flannel. If the pain is severe despite the use of the salicylates internally, fomentations as hot as can be borne or hot cloths lightly wrung out of Fuller's lotion (sodium carbonate, 3vj—24.0; laudanum, 3j—30.0; glycerin, 3ij—60.0; and water, 3ix—270.0) are beneficial. As salicylic acid is absorbed through the skin, it may be used in the following formula:

R.	Acidi salicylici,	3iv (16.0);
	Ol. terebinthinæ,	f3iv (15.0);
	Adipis lanæ hydrosi,	
	Adipis,	āā 3iv (16.0).—M.
Sig. Apply to joints thrice daily.		

Methyl salicylate, by local application, is of service. It is put on the skin

¹ Miller and Lusk, *Jour. Amer. Med. Assoc.*, 1916, lxxvii, 2010.

² *Jour. Amer. Med. Assoc.*, 1919, lxxiii, 1579.

over the affected joints drop by drop, and the joint then enveloped in gutta-percha tissue and a flannel bandage applied to it. Cold compresses and the ice-bag to the joints have been strongly advised, particularly by German authors. Liniments containing the oil of wintergreen are serviceable. The affected joints should be kept at perfect rest, and this is best accomplished either by padded splints and a roller bandage or plaster casts. Blisters near the joints involved and the light application of the Paquelin thermocautery are sometimes serviceable. Taylor has successfully employed currents of hot air applied by means of an instrument (electrotherm).

The treatment of the *complications* will be considered under their appropriate headings. Should, however, hyperpyrexia occur during the progress of the affection, it is to be relieved by cold affusions, since large doses of internal antipyretics are of themselves dangerous. It may also be stated that the cardiac complications—endocarditis, pericarditis, and endopericarditis—rarely require special remedies. If marked cardiac asthenia appears, as indicated by the feeble first sound, the salicylates may be replaced by salicin, which is less depressing in its effect upon the heart. Cardiac stimulants may be required. A copious pericardial effusion calls for paracentesis (*vide* Serofibrinous Pericarditis). Gürich¹ succeeded in curing 98 out of 125 patients with articular rheumatism by tonsillectomy.

During convalescence the patient should not be allowed to get out of bed too early. My own rule has been to keep him in bed for a week after the temperature and pulse-rate have returned to the normal, and after the pain has disappeared, except it be during the hot season. These precautions are taken to avoid the occurrence of relapses and to avoid strain upon a heart that is presumably injured. After the patient goes into the open air he should be told to avoid cold, and wet in particular. During this period iron is to be employed until the blood examination fails to show anything abnormal. For the stiffness and swelling that sometimes persist, or disappear very slowly after the acute attack, massage and the application of hot water or warm baths seem to yield the best results.

SUBACUTE ARTICULAR RHEUMATISM

This is, as a rule, a sequel of acute rheumatism, and may occur, though rarely, in persons who have not had a previous acute attack. Both the local and general features are of a mild type, but the course is apt to be prolonged into two, three, or more months. Usually the local symptoms are confined to one or two of the larger joints, with little swelling or redness, and the pain is slight except on movement. The temperature rarely exceeds 101° F. (38.3° C.), and at times may be practically normal. Though the course is prolonged, the joints usually return to their normal state; occasionally, however, the disease becomes chronic. As in the acute form, so in the subacute, anemia becomes well marked and cardiac complications are not uncommon, particularly when the disease occurs in children.

The **treatment** embraces, in addition to the usual antirheumatics, the use of iron, quinin, cod-liver oil, and, when practicable, a change to a warm climate. The affected joints demand hot applications and massage. Zabalita has employed subcutaneous injections of oxygen, using 100 c.c. at the site of pain and sometimes injecting all the larger joints at one sitting, using up 2, 4, or more liters, with encouraging results.

¹ *Münch. med. Wchnschr.*, February 8, 1910, lvii, No. 6.

GONORRHEAL ARTHRITIS

Definition.—A septic synovitis caused by the gonococcus. It has no connection with true rheumatism. It usually manifests itself toward the close of an attack of gonorrhea, but it may develop during the active stage of the disease or at any period during the course of gleet.

Pathology.—The signs of ordinary synovitis are generally found in the affected joints, though, not rarely, the inflammatory process is periarticular (*gonorrheal tenosynovitis*). In these cases the inflammation may travel along the sheaths of the tendons for a considerable distance. Synovial effusion may occur, and rarely may be purulent, this being most frequent in gonorrheal inflammation affecting the wrist and hand. Gonococci have been found in the effusion, especially in the acute stage, and it is now thought by many writers (Finger, Councilman, and others) that the gonococcus may be the only infective agent concerned in the morbid process. Others contend that the metastatic inflammation of the joints is due to the presence of pyogenic cocci. The disease is present in 2 per cent. of all cases of gonorrhea in males, and rarely occurs in females (Gaither); it may follow any urethral discharge or may be associated with leukorrhea. C. Lucas has collected 23 cases of gonorrheal rheumatism in infantile subjects of ophthalmia.

Clinical Symptoms.—Two leading varieties, acute and chronic, are encountered: (1) *Acute Gonorrheal Arthritis*.—This may be very mild, amounting merely to slight fugitive pains about one or more joints, without swelling or redness (*arthralgic form*). The typical, acute form, however, presents the symptoms of a severe fibrinous or serofibrinous inflammation of a single joint, developing quickly. The pain is often violent; there is swelling of the joint with extension along the course of the tendons, and the condition is obstinate. Unless pus be present (a rare event) the constitutional features do not correspond in severity with the local. There are many instances in which the complaint begins as a *polyarthritis*, with subsequent concentration upon one or two of the larger articulations, especially the knees or ankles. Fibrinous ankylosis usually remains as the resulting condition. In infants, however, this condition is transitory as a rule.

Complications and Gonorrheal Septicemia and Pyemia.—*Acute endocarditis* may be of gonorrheal origin, and undoubted instances are common. In the inflammatory products of this condition Hering has found the gonococci, as has also Councilman, in the heart muscles (gonorrheal myocarditis). Rarely gonorrheal endocarditis assumes the ulcerative or malignant form. As the result of invasion of the blood by the gonococci, *suppurative arthritis* may develop and form a part of *gonorrheal septicemia*. Instances of severe, rapidly fatal general infection in gonorrhea are probably always associated with foci of suppuration in the urinary tract (Osler). Among the widespread complications, *embolic*, *septic pneumonia*, and *iritis*, deserve special mention.

(2) *Chronic Gonorrheal Arthritis*.—This occurs (a) as a serous effusion (*hydrarthrosis*), and (b) as a chronic inflammation of the articular and periarticular structures (synovial membranes, bursæ, periosteum, and tendons with their sheaths). The former is usually monarticular, settling with especial frequency in the knees, and may be wholly painless. The latter is more or less painful—causes dense swelling of the joint, and frequently of the structures for some little distance above and below the latter. Both forms lead to great restriction of motion. The os calcis may be the seat of gonorrheal periosteal inflammation with or without exostosis. It is sometimes called the painful heel of gonorrhea.

The **diagnosis** cannot be determined apart from the history of urethral infection, or the detection of the gonococci in the blood or the joint effusion. For diagnostic purposes, Irons uses an emulsion of killed bacteria, suspended in glycerin, making inoculations after the method of von Pirquet, with a control. A papule is formed in a few hours, with surrounding hyperemia, disappearing by the third day. The reaction is classed as positive when over 5 mm. in diameter. The acute form is distinguished from *acute articular rheumatism* by the more intense pain, the extent to which the periarticular tissues are involved, and the negative character of the general symptoms. The chronic variety must be discriminated from *chronic synovitis* due to other causes.

Treatment.—I have never seen the slightest benefit from internal medication in gonorrheal arthritis except possibly from the use of mercury. J. C. Wilson has obtained excellent results from massive doses (mxx-lx—0.6–3.75 t. i. d.) of the syrup of iodid of iron.

The specific organisms linger in the posterior urethra of the male and the first indication to be met is the eradication of the primary focus of infection by local measures and by constitutional therapy, vaccines. When this is done good results from the treatment of the arthritic complication may be achieved, but not until then can much be accomplished.

Chiari tabulates 443 cases in which vaccine therapy was applied with commercial or autogenous vaccine, of which 367 were cured. Ramond and Maillet have reported similar experiences, while Miller reports cures with non-specific vaccines and foreign proteins given intravenously. Fuller¹ reports good results from seminal vesiculotomy.

Local measures, however, are of paramount importance. Absolute rest to the part is indicated, and the limb should be placed upon a splint; then, after making an appropriate anodyne application (ungt. ichthyol. or ungt. belladonnæ), it should be bandaged as firmly as possible. In other instances complete immobilization in plaster-of-Paris dressing gives good results. In acute cases the patient should be anesthetized, and after the procedure, if pain be great, a hypodermic injection of morphin may be given. Dry heat, either sand-bags or the heating apparatus (oven), is useful. In *chronic forms* the aim should be to remove the effusion and swelling, and to restore the natural motility. For the latter two indications massage and passive movements are best. Hydrarthrosis may also be diminished by the use of the thermocautery, at intervals, and blisters.

VARIOLA

(*Small-pox*)

Definition.—Variola is an acute contagious disease, characterized by its sudden onset and severe period of invasion, followed by a remission of the fever and an eruption of papules, which pass through the stages of vesicle, pustule, and scab. The stage of pustulation is accompanied by secondary fever. Variola runs a variable course, but on the whole, has become far milder in character in recent years.

Historic Note.—Small-pox has existed from the earliest antiquity in India, Africa, China, and other Eastern countries. During the thirteenth century (1241) it entered England; in the early part of the fourteenth, Ireland; and in the latter part of the fifteenth, Germany. In 1507 it was imported to America, and first appeared in the West Indies; a little later

¹ *Medical Record*, New York, June 15, 1912.

(1520) the Spanish troops conveyed the disease to Mexico, where it destroyed not less than 3,500,000 people. It was brought to the United States from Europe in 1649, and gained its first foothold in Boston, whence it progressed at intervals in a westerly direction to the western coast-line. During the Spanish-Cuban War the disease was transferred from Cuba to the Southern States, afterward spreading to many of the Northern and Western States. In the United States, for the years 1903 and 1904, there occurred 42,590 cases, with 1642 deaths, and 25,106 cases with 1118 deaths respectively (Wyman). Variola exhibits great variability in intensity in different epidemics.

Pathology.—The eruption of small-pox consists in an inflammatory cellular infiltration of the *rete mucosum*, and has four successive stages: (1) *Papular*, (2) *vesicular*, (3) *pustular*, (4) *scab*.

(1) *The Papule.*—At first there is a hyperemia of the papillæ of the skin appearing as small red spots. These soon become round, discrete patches that may be rolled like shot under the skin, and then become elevated, owing to the increase in the cells in the *rete mucosum*.

(2) The *vesicle* appears at the apex of the papule, and results from a circumscribed elevation of the superficial layer of the epidermis in consequence of the mechanical pressure exerted by the fluid exudate, which is excited by peripheral inflammation. The vesicle is not unicellular, but is loculated (fibrinous reticuli), and contains serum, leukocytes, fibrin-filaments, etc. (Weigert). The vesicle shows central umbilication, which corresponds with the necrotic area.

(3) The *pustule* is formed by the filling of the reticuli with leukocytes. Cellular infiltration and swelling of the true skin beneath the pustule occur, as a rule, as the result of diapedesis. Moreover, suppuration may involve the *cutis vera*, and as a consequence scarring results. The pustules may dry up, but commonly rupture, and in either case the result is (4) *scabbing*.

Recently Councilman, McGrath, and Brinckerhoff have described the specific lesion as a focal degeneration of the stratified epithelium, accompanied by serous exudation and the formation of a reticulum.

The eruption has run an atypical and even abortive course in the cases occurring in recent years. An early maturation of the papules has been observed; in many cases they become solid, conical elevations with a small vesicle at the summit. W. M. Welch states that the lesions seemed to involve only the outer epidermis.

The mucosa of the mouth, pharynx, and, rarely, the esophagus and the rectum may be the seat of a variolous eruption, and the plaques of Peyer may be somewhat swollen. The eruption also appears in the larynx, the trachea, bronchi, conjunctivæ, and nasal mucosa, where ulcers rather than true pustules are seen.

Hemorrhagic small-pox presents extravasations occurring in the serous and mucous membranes, the connective tissue, the parenchyma of the various viscera, and also, though much less frequently, in the nerve-sheaths, bone-marrow, blood-vessel walls, and the muscles. In this form the spleen is firm (Ponfick, Osler), and the liver is sometimes enlarged and the subject of fatty degeneration. Hemorrhagic infarction of the lung occurred in 5 out of 7 cases examined by Osler.

Secondary Lesions.—The catarrhal inflammation of the larynx may extend in depth till it touches the perichondrium of the cartilages (perichondritis), and a croupous exudate in the larynx may often coexist with edema. Lesions are present in the lungs, some of them frequently (general bronchitis, bronchopneumonia), and others rarely (hypostatic congestion, lobar pneu-

monia), and *pleuritis* may be observed. Cloudy swelling, diffuse inflammation, and sometimes fatty degeneration of the *liver* have been noted; the *spleen* is enlarged and pulpy as a rule. The *heart* may show myocardial alterations—chiefly parenchymatous and fatty—and rarely endocarditis and pericarditis occur. The *kidneys* show cloudy swelling, an acute degeneration of the epithelium, more marked than in other infections, occurs. “An acute glomerulonephritis was found in 5 cases out of 54” (Councilman). Weigert found that at the commencement of the stage of suppuration the microscope revealed “small-pox cylindric masses” in the various viscera (coagulation necrosis).

Etiology.—Bacteriology.—The investigations of Councilman and his associates have resulted in the discovery of a protozoön in the epithelial cells of the lesions. There are two cycles of development, intracellular and intranuclear, the latter only occurring in small-pox. Transmission of these organisms by the dried epithelial scales may be responsible for the spread of the disease. These findings have been confirmed by Calkins and Howard and Perkins of Cleveland. M. Funck found protozoa (probably the same organisms previously described by Pfeiffer) in all vaccinia pustules examined. They are usually from 1 to 3 μ in diameter, and larger cyst-like bodies filled with spores also occur. Iskigami has also discovered protozoan-like bodies in the epithelial scales of the vaccine pustules, lymph, etc. Haushalter and Etienne consider the hemorrhagic symptoms in small-pox due to secondary infection with the streptococcus, since they have found this organism in the blood of those dead of hemorrhagic variola. Widal and Sabrazes have also noted the streptococcus in autopsies upon small-pox cases.

Predisposing Causes.—The *receptivity* for variola is wellnigh universal, and among the few who have enjoyed immunity were three distinguished physicians—Diemerbroeck, Boerhaave, and Morgagni. It may be said that one attack confers permanent immunity, but exceptionally a second or even a third may occur. *Vaccination*, also, if successful, affords future protection against variola, but to this rule exceptions are not infrequent.

Age.—All periods of life are liable to the disease, but the very young are affected in a relatively larger proportion than older persons. During the entire puerperal stage there is an increased liability to the disease. It rarely affects the fetus *in utero*, and most babes even, who are exposed to the virus at the time of birth, will not take the disease if immediately and successfully vaccinated.

Sex is without influence.

Season.—In temperate climates, most cases occur during the winter months. On the other hand, in tropical countries it is said that the worst cases occur during the hottest months.

Race.—Among uncivilized peoples variola spreads with frightful rapidity, the negro and other very dark races being affected in larger numbers and more severely than whites, since they are not so generally vaccinated. A dread of the infection predisposes to its occurrence.

THE CONTAGION; WHERE FOUND; MODES OF CONVEYANCE AND OF INFECTION.—One case of variola is *prima facie* evidence of the existence of another, the poison having been transferred. The specific poison exists in the blood and in the secretions and excretions (most probably), but mainly in the pustules and dry scabs and in exhalations from the lungs and skin. The contagion is conveyed principally from the sick to the healthy by the dust-like particles of the dried scabs.

Modes of Infection.—(a) *Inoculation* with either the blood or the contents of the eruption or the dissolved dry scabs is followed by variola. (b) Contact

with, or proximity to, a patient suffering from small-pox is very apt to convey the poison, with resulting variola in the person thus exposed. To what distance the contagion can be conveyed through the air is not known, but it is probably considerable; and all authors are agreed that it is one of the most infective diseases with which we are acquainted. It is contagious from the earliest active stage to the end of convalescence, and possibly even during the stage of incubation. (c) Transmission by *fomites* is common, the poison adhering to clothes, body- or bed-linen, etc., and evidence is not wanting to show that the poison is highly tenacious of pathogenic power. Its vitality is retained after death, and the room occupied by a patient, the bedding, and the articles of furniture all serve to convey the disease unless thorough disinfection be enforced. The *infection atrium* for the poison into the system is probably the *respiratory tract*. Rothwell¹ reports a case of small-pox *in utero*, without signs or symptoms of the disease in the mother.

Fig. 15.—Variola (Royer).

Clinical History.—Incubation.—This stage varies with the mode of communication of the poison. If following inoculation, the symptoms appear in six or seven days; when originating from infection, usually in twelve days, though this stage may be either lengthened by a day or two or shortened to an equal extent. During a portion of this period complaint may be made of certain ill-defined symptoms, but these are usually absent. **Invasion** is sudden and accompanied by characteristic signs. These are—a *severe rigor*, *high fever*, *headache*, and *intense lumbar pains*. Instead of the usual severe rigor, repeated chills, extending over twelve to twenty-four hours, may occur. The symptoms of the onset have been milder in the recent outbreaks, although similar in character to the severer types of former epidemics. During the preliminary fever the *respirations* are accelerated, the *pulse* becoming decidedly more rapid and there may be generalized bronchitis. The *tongue* is coated and slight pharyngitis may exist. There are anorexia, general vomiting, and constipation

¹ *Northwest Med.*, September, 1917, p. 265

or rarely diarrhea. Restlessness, delirium, and stupor are the principal nervous symptoms observed. Infective *albuminuria* is common. In the female menstruation is apt to occur.

The **physical signs** referable to the lungs are few, and consist of a few dry and, later, moist râles, heard on *auscultation*. *Palpation* detects splenic enlargement. From the second day the so-called *initial rashes* may appear: (a) the *diffuse scarlatinous eruption*, which in no way differs from ordinary *scarlatina*; (b) the *measly eruption*, which may be diffuse and present a striking similarity to that of measles. Either associated with these or occurring independently there may be a hemorrhagic eruption (usually purpura), the petechiæ coming out by natural selection, mainly upon the hypogastric region or the inner surfaces of the thighs and in the axillæ (Simon). The initial rashes occur in a considerable proportion of cases (10–15 per cent.). The *stage of invasion* lasts three days as a rule. The temperature then declines rapidly, while at the same time the true *variola eruption* appears upon the skin and mucous surfaces. It develops first upon the face, particularly upon the forehead and the hairy scalp, and spreads in a downward direction till it reaches the legs, where it last appears. The skin in the femoral triangle rarely shows the true variola eruption. Each pock passes through the various stages noted in the pathologic description—viz., papule, vesicle, pustule, and scab; and when the stage of pustulation has been reached a secondary fever develops. During the following remission of fever the headache, lumbar pains, etc., subside. The fever of suppuration which then succeeds is accompanied once more by marked constitutional disturbances, particularly nervous derangements (wild delirium, etc.), and at this time complications are also apt to develop. On the eighth or ninth day of the eruption (the twelfth or thirteenth day of the disease) the pustules begin to dry up, forming yellow crusts; the redness and swelling of the skin subside; and two or three days later the scabs loosen and are thrown off. During this stage the fever again declines in company with the constitutional symptoms, and convalescence ensues. As previously stated, when suppuration involves the true skin scars are the inevitable result. The hair drops off sometimes, even to the extent of total alopecia, but is generally renewed.

LEADING SYMPTOMS AND COMPLICATIONS.—(a) **Eruption.**—The eruption in the more typical cases appears at the end of the third or on the fourth day, coming out first upon the forehead, particularly along the border of the hairy scalp, and spreading in a downward direction in regular progression. It appears in the form of slightly elevated maculæ, which are at first of a pale red color, and later assume a darker red hue, resembling small fleabites. These increase in size during the next forty-eight hours, at the end of which period they are developed into (1) *papules*. The change of character is accompanied by intense itching and burning of the skin surface. To the feel they are papular, like shot under the skin. The eruption is always most abundant upon the face and scalp, while the hands and fingers are the next most favored seats. At the end of the third day (the sixth day of the disease) the conical apices of the papules contain liquid, forming thus (2) *vesicles*. The latter increase in size till the entire papule is converted, at the same time acquiring more and more decidedly a central umbilication. Puncturing a vesicle does cause it to collapse, but allows only a small portion of its liquid contents to escape, owing to its reticulated character. As the vesicle increases in size its contents become opaque, and in three days more, or about the sixth of the eruption, the vesicles become (3) *pustules*. Umbilication now disappears, and the pustule looks full and well rounded, and is surrounded by a red border or “halo.” If the pocks be close set, as on the face, wrists, and fingers, the intervening skin is

inflamed and swollen and the itching and burning become almost intolerable. The pustules may coalesce along their edges, and thus the eruption becomes confluent. The eyes are closed as the result of swelling and tumefaction of the face, and the hands and feet assume a rounded, ball-like appearance. The face, as a whole, is markedly misshapen and is ultimately disfigured. When the pus is not liberated (a comparatively rare event), its desiccation begins on the ninth day (the twelfth day of the affection); if the pustule is ruptured earlier (as when confluence occurs), it begins at an earlier day. (4) The *scabs* now form, and remain until about the twelfth day of the eruption, and when pits or scars result they gradually fade until they remain as permanent whitish spots.

The eruption upon the mucous membrane develops simultaneously with that of the skin, and among favorite surfaces for its appearance are the mouth, tongue, soft palate, and pharynx (causing *dysphagia*), the nasal chambers (causing *coryza*), the larynx (causing *hoarseness*), the trachea and bronchi (causing *bronchitis*). This mucous efflorescence does not proceed to the development of pustules, but forms ordinary ulcers as a consequence of early

Fig. 16.—Temperature of a case of variola, from a patient in the Municipal Hospital, Philadelphia. A. F.—, aged three years; not vaccinated.

maceration of the superficial layers of the mucosa, and these ulcers also may become confluent.

The *skin* presents certain complications that are always secondary and are deserving of mention (erysipelas, abscess, gangrene, bed-sores).

(b) **The Fever.**—The temperature at the onset rises rapidly, and may touch 103° or 104° F. (39.6°–40° C.) on the first day, its range being high and of the continued type during the invasion period. Evening temperature of 105° F. (40.5° C.) or higher may be observed, and in three days (or with the first appearance of the papules) the temperature remits, but does not intermit in true variola. It remains at a low elevation till the stage of suppuration is reached, when a fresh rise occurs. This secondary fever-curve is apt to show exaggerated points of elevation and deep remissions. The latter are generally the result of septic absorption (the fever of suppuration). Secondary fever, since the variolous infection has grown milder in type, is often slight or may be wanting (*vide supra*). This period lasts from one to three or four days. When desiccation of the pustules begins defervescence also commences, and proceeds in a gradual manner by lysis. There may be a postvariola rise, and, if so, its presence is to be attributed to some sequel or other.

(c) **The Circulatory System.**—The *pulse* is soft and much accelerated (100 to 130) and of good volume during the invasion stage. It is slower during the period of remission, only to be greatly increased in frequency during the second stage of fever. During the latter period it may, owing to cardiac failure, become very rapid, and finally irregular or even intermittent. Simple *endocarditis* rarely, and *pericarditis* somewhat more commonly, occur as complications. In typical cases the leukocyte curve shows two exacerbations—one about the eighth day, another from the twelfth to the fourteenth day.

(d) **Respiratory Tract.**—The *laryngitis* and *pharyngitis* which are due to the presence of pocks in the respiratory mucosa have already been mentioned. *Laryngeal perichondritis* with edema of the glottis, the latter perhaps being the result of a direct extension of the pock-ulcers to the perichondrium, may arise; it is ominous. Chief among the grave secondary complications is *bronchopneumonia* (inhalation pneumonia); and *lobar pneumonia* also occurs, though rarely. *Pleurisy* is not infrequent, particularly as an associated condition in bronchopneumonia.

(e) **The Digestive System.**—The variolous efflorescence in the buccal and pharyngeal mucosæ may be an agency in predisposing to a secondary inflammation in adjacent organs—*e. g.*, suppurative otitis media, suppurative parotitis, pseudodiphtheria, etc. *Palpation* almost always shows an enlarged spleen, and not infrequently an enlarged liver. The vomiting which is usual at the onset is due to a catarrhal condition of the stomach. Constipation is common, but diarrhea is also sometimes met with, being excited by a catarrh of the large intestine, and is especially common in children. The pocks may be found in the rectum and they sometimes excite dysenteric symptoms.

(f) **The Nervous Symptoms.**—The chief of these have been already pointed out. *Violent delirium* (previously alluded to) may be followed by fatal *coma*, and in children *convulsions* may be seen. Very rarely paraplegia has been observed during the attack, though it is more common during the convalescence, and is then due to different causes, such as peripheral neuritis and disseminated myelitis (Westphal). *Multiple neuritis* may be a sequel or the pharyngeal nerve may alone be affected. Among other conditions rarely arising during convalescence are insanity, epilepsy, aphasia, and hemiplegia.

(g) The **joints** may be swollen and painful after small-pox, and in rare cases periostitis may be observed.

(h) **Renal Symptoms.**—Welch and Schamberg made analyses of the urine in 128 cases of variola, and found the presence of albumin in 65 per cent. and tube-casts in 45 per cent.; they believe that the albuminuria in most cases is the expression of a structural change due to the small-pox poison. The clinical symptoms of variolous nephritis are mild as a rule. Hemorrhagic nephritis may occur, but it is rare.

(i) **The Special Senses.**—The pustules may form upon the conjunctivæ and eyelids, and several important conditions result from this variolous involvement of the eye—*viz.*, conjunctivitis, keratitis, choroiditis, and panophthalmitis. Hebra met with ocular complications in 1 per cent. of 5000 cases of small-pox. Otitis media has already been mentioned.

Special Clinical Forms.—There are two unusual types of variola that are important in being severer than the moderate (discrete) form.

(a) **The Confluent Form.**—This is the result of an abnormally severe infection, and is less common than formerly. The *ushering-in symptoms* are very severe, and the eruption may appear as early as, or even before, the third day, when the temperature remits. The separate papules are

vastly more abundant and close-set; and after the stage of pustule is reached the face and hands present an uninterrupted area of suppuration. The deformity of the countenance is correspondingly pronounced. Naturally, the *local symptoms* are intense and the fever and its concomitants are in exact proportion. The *nervous symptoms* often predominate. Salivation is frequent. The eruption may also entirely cover the mucous surfaces. The *lymphatics* of the neck may be greatly swollen—a circumstance that contributes to the facial disfigurement. The various complications previously adduced are of comparatively frequent occurrence, and following these a general pyemic process may develop. When death occurs it is usually preceded by the *typhoid state* (typhomania, tremors, a rapid, feeble pulse, dry, brown tongue, and diarrhea). On the other hand, if recovery ensues, it is tardy.

(b) **Black Small-pox.**—In this form the blood is much changed, so that hemorrhages into the skin, mucous membranes, and various viscera occur. It is important to distinguish several subvarieties, as follows: (1) A *benign* form, in which blood is infused into the pustules when patients are allowed to leave their bed too early in convalescence. Here the condition is due to the effect of gravitation, and hence is confined almost solely to the lower extremities. (2) Doubtless the ordinary variolous eruption may become *slightly hemorrhagic* without aggravating the constitutional condition. (3) A *dangerous hemorrhagic* tendency may be manifested. During any of the eruptive stages—papular, vesicular, or pustular—hemorrhages may occur into the eruption, and, moreover, free bleedings may take place from the various mucous surfaces. The initial symptoms are usually intense, the eruption abundant, and in consequence of the hemorrhages collapse often occurs. The most serious complications, pneumonia, diphtheria, and nephritis (followed by uremia), are also apt to develop and terminate life. This and the subsequent subvariety are truly anomalous. (4) A not uncommon form is met with in which the *acute hemorrhagic diathesis* develops during the period of invasion. Its onset is characterized by the usual symptoms intensified, and as early as the second day ecchymotic patches appear upon the skin surface and grow rapidly by peripheral extension, the mucous surfaces also showing more or less extensive ecchymoses. The variolous eruption rarely appears, though occasionally shot-like papules may be detected. The temperature may be slightly elevated, but is rarely high. Death often occurs before the time for the appearance of the characteristic eruption.

There are also varieties of small-pox that pursue an abnormally mild course. Of these (c) **varioid** deserves first place. By this term is usually meant small-pox occurring in individuals who have been protected by a successful vaccination, but it may also be the result of natural insusceptibility. Hence variola and varioid are one and the same affection. The *initial symptoms* of varioid do not differ either in character or severity from those of true variola, but the general course of the attack is peculiarly prone to manifest irregularities. In the pre-eruptive stage an erythematous rash is very common, and its appearance is regarded by many as being of value in discriminating varioid from variola.

When the *regular eruption* appears, the fever falls to normal and remains there. The rash comes out by the end of the first or on the second day, the papules being scanty, but may appear first upon the trunk, not the face. They are identical with the papules of variola, as is true also of the vesicles; but pustulation rarely develops, since resolution takes place, but, as a rule, before the latter stage is reached.

The *secondary fever* is either very slight or entirely wanting. The mucous surfaces are affected slightly. Papules and vesicles may be found in close

proximity; not so in variola. Desiccation begins between the fifth and seventh days of the eruption (the eighth and tenth of the disease), and hence, as compared with variola, the course is cut short and serious complications almost never occur. There has been noted the same marked tendency to extreme mildness of phenomena that characterize variola in the recent epidemics.

(d) An **abortive form** is occasionally observed. It is characterized by the intensity of the invasion symptoms, but these subside, and the patient enters at once upon a stage of speedy recovery.

An exceedingly mild type may arise during seasons of epidemic prevalence of the disease, either with or without a scanty and undeveloped eruption; the diagnosis is made from the etiologic circumstances.

Diagnosis.—With a clear history and the presence of the characteristic features a positive diagnosis is a simple problem. But at any period before the papules are fully developed it may be confounded with certain other acute infections, notably cerebrospinal meningitis, typhus fever, scarlatina, and measles. After the variolous eruption makes its appearance the disease may be confounded with impetigo contagiosa, pustular syphiloderm, and varicella. Councilman¹ advocates two methods to decide the diagnosis: one is by corneal inoculation on the rabbit, the other direct microscopic examination of the suspected lesion. Force and Beckwith² have discovered an intradermal reaction produced with vesicle contents. The method pursued is to make intradermal tests on sensitized rabbits or guinea-pigs.

Differential Diagnosis.—In *typhus fever* the onset is very like that of small-pox. The former may, however, be distinguished by its peculiar etiologic factors, especially its origin by importation or its non-prevalence in the vicinity; the appearance of the eruption, first upon the trunk (chest and abdomen) in the form of maculæ, and later becoming petechial. Moreover, in typhus the temperature does not remit with the appearance of the eruption.

From hemorrhagic small-pox *typhus* is sometimes distinguished with great difficulty. In the former death often occurs before the eruptive stage is reached. In typhus shot-like papules are never detected, whereas they are sometimes found in hemorrhagic small-pox.

Hemorrhagic small-pox may be simulated by *cerebrospinal meningitis*. If the history be not clear, lumbar puncture will settle the doubt.

Scarlatina may early be distinguished from the erythematous (scarlatinous) rash which often precedes the appearance of the variolous eruption; this is, as a rule, neither so intense nor so uniformly distributed over the skin surface of the body as in true scarlatina. *Hemorrhagic scarlatina* may readily be confused with black small-pox.

The *macular stage* of the eruption may be confounded with *measles*. The absence of the characteristic prodromes and symptoms of invasion belonging to the latter disease, the redness and swelling of the conjunctivæ, the photophobia and marked coryza, the stubborn cough, and increased fever after the eruption appears, make the separation easy, as a rule. After the maculæ develop into hard, shot-like, conical papules the scales are turned in favor of variola.

Impetigo contagiosa presents no initial stage; it begins as vesicopustules (not papules) which appear "on the normal skin and are superficial and enlarge by peripheral extension, often attaining the size of a 10-cent piece and having a flat appearance" (W. M. Welch). The patient may infect new areas by scratching. Scars do not result.

Syphilis distinguishes itself by a milder initial stage, by the indurated base

¹ Osler's *Modern Medicine*, vol. ii, page 295.

² *Jour. Amer. Med. Assoc.*, August 14, 1915, p. 588.

of the pustule, by the appearance in crops of the skin lesions, and by the polymorphous character of the latter. There is neither umbilication nor characteristic pitting after the scabs fall, but a coppery hue.

To differentiate certain mild cases of discrete small-pox (in the non-vaccinated) and varioloid from *varicella* is difficult. In the table below, however, will be found contrasted points of distinction:

VARIOLA	VARICELLA
<i>History</i>	
Absence of previous attack.	Same.
Previous or existing case in the vicinity.	Traceable to previous or present case of varicella.
Not successfully vaccinated.	Negative.
Occurs at any age.	More commonly in childhood.
Characteristic pre-eruptive stage—rash on the third day.	Eruption not preceded by prodromes; develops more rapidly.
Vaccine or lymph cause typical skin reaction.	Varicella vaccine produces no reaction.
Sacral pain, high fever, and vomiting common.	Quite uncommon.
<i>Eruption</i>	
Appears first upon the forehead, extending downward.	Appears first over parts covered by clothing. No regular procession over the body.
Vesicles uniform in size, umbilicated, and deeper seated.	Vary in size, sharply elevated, rarely umbilicated, and feel soft and velvety.
Eruption contains serum, later pus.	Only serum, giving pearly translucency.
Most abundant on face and fingers.	Most abundant upon back and legs.
Various stages of eruption observed at points removed from each other.	Various stages side by side.
Pin-prick does not cause collapse of vesicles, being multilocular.	Does cause collapse, being unilocular.
Itching less marked, early.	Highly characteristic.
Secondary fever usually present.	Absent.

Park found that monkeys are susceptible to inoculation with small-pox virus, whereas that taken from cases of varicella produced no result.

The **prognosis** depends upon (a) the degree of severity of the type, the severer forms (confluent and certain of the hemorrhagic) being grave. The hemorrhagic variety, in which large ecchymoses suddenly develop, is almost invariably fatal, and often before the cases have advanced to the eruptive stage. The aggregate number of pocks that appear and the gravity of the infection are, as a rule, proportionate.

(b) The prognosis is modified by *individual peculiarities* (age, intemperance). Thus it is more fatal in the very young than in older subjects, more fatal in the intemperate than in the temperate, and so on.

(c) Complications increase the death-rate considerably. Of these, bronchopneumonia, lobar pneumonia, acute nephritis with uremia, septicopyemic conditions, pseudodiphtheritic angina, and pericarditis are most potent for evil. Among the foremost serious symptoms may be mentioned excessive vomiting, wild delirium, coma, a temperature of 106° F. (41.1° C.) or over, urgent diarrhea, and dysentery.

The death-rate has been computed to be between 15 and 30 per cent., varying, however, with each epidemic. Welch's statistics from the Municipal Hospital, Philadelphia, are as follows: In 2831 cases of variola, 54.18 per cent., while in 2169 cases of varioloid only 1.29 per cent. died. During the recent wide-spread prevalence of the disease in the United States the mortality rate was unprecedentedly low. Welch and Schamberg found the death-rate

unvaccinated persons 49.45 per cent. in the blacks and 44 per cent. in the whites.

Treatment.—The varied indications in the treatment of small-pox will be considered separately:

(1) **Prophylaxis.**—The rules that have been laid down elsewhere (*vide* Treatment of Typhoid Fever) for disinfection in infectious diseases must be rigidly enforced in this affection. Quarantine (*public and private*) must be secured if the deadly progress of small-pox is to be averted. Absolute isolation cannot be carried out successfully in private houses, and in view of this fact special, well-equipped hospitals should be provided for the reception of the disease. It is important also to remember that persons who have been afflicted with the disease cannot with safety to others resume their former places, either in the family or in society at large before they are completely convalescent. The best means of prevention, however, is vaccination (*vide* p. 196).

(2) **General Management.**—The room occupied by the patient should be large and freely ventilated (an essential matter, though strong drafts are to be avoided), and all carpets, curtains, and articles of furniture not absolutely needful should be removed.

The *diet* should receive careful attention, and should be varied according to the stage of the affection. During the initial stage it must be restricted to liquid nourishment (milk, animal broths, etc.), and, in addition, cooling drinks, including ice, lemonade, and other of the various fruit-juices (diluted). During the stage of remission we may add soups, jellies, eggs, toast, and with the onset of the stage of suppuration a supportive diet, reinforced by the judicious use of stimulants, is an essential part of the treatment. Light forms of nourishment must now be given in definite quantities and intervals.

(3) The **fever and associated symptoms** during the invasion stage are best controlled by the cold or gradually cooled baths, which possess all the advantages in this disease that they command in typhoid fever. Cold sponge-baths, the ice-cap, or the cold pack may be resorted to if cold immersion baths are not accessible to the patient. The internal antipyretics must be given with a sparing hand, if at all, and only as antiseptic agents, on account of their depressing effects.

The therapy of this stage also embraces the treatment of certain symptoms. The vomiting may be incessant and exhausting, and chipped ice, champagne, dilute hydrocyanic acid, and cocain hydrochlorate should be tried in the order mentioned. If diarrhea be severe it should be checked (though neither wholly nor suddenly) by the use of arsenite of copper, the acetate of lead (gr. ij—0.13) and opium (ext., gr. $\frac{1}{4}$ —0.016), in combination, or by bismuth salicylate (gr. v—0.3) and β -naphthol (gr. iij—0.2). The nervous symptoms are usually restrained by the cold affusions, but occasionally a wild delirium may necessitate a combination of sodium bromid (gr. x to xv—0.6–1.0) with the deodorized tincture of opium (m \ddot{x} v—0.3), given every two or three hours. Very often the wise administration of stimulants removes all necessity for the use of further means of overcoming the nervous symptoms. The catheter must be used if retention of urine should occur. For the intense pains that belong to this stage no other remedy can be compared with morphin sulphate (gr. $\frac{1}{4}$ to $\frac{1}{2}$ —0.008–0.16), to be administered hypodermically, and repeated if necessary.

(4) As previously stated, the **eruption** appears with the termination of the initial febrile period, and deserves the closest attention. The indications are twofold: (a) to limit the eruption as far as is possible, and (b) to modify its course, so that extensive suppuration and consequent disfigurement may be prevented. Ablutions with lukewarm water, to which may be added some

stimulation with alcoholics and other cardiants, the assiduous use of cold sponges or gradually cooled baths, and nourishing foods. *Laryngeal perichondritis* with edema of the glottis may suddenly demand tracheotomy. To avoid the development of *bed-sores* an air-cushion should be provided, if needful. Care should also be exercised to prevent ocular complications, and their occurrence demands supportive treatment. I have much confidence in the use of cold compresses, instilling into the eyes at the same time a solution of boric acid (gr. x to xv—0.6–1.0 to fʒj—30.0).

(7) **Special Modes of Treatment.**—These would be found to be numerous, were we to enumerate all of them, but only those based on the principle of antiseptics are worthy of notice. According to one plan, which has many advocates, antiseptic agents are administered internally. The remedies that have been most frequently employed in this manner, and with perhaps the most promising results are the sulphocarbolates, sodium salicylate, carbolic acid, creasote, mercuric chlorid, and the sulphites. Woodson adopted as a plan of treatment in the Holguin epidemic daily scrub-baths, 1:2000 mercuric chlorid, and open-air treatment. Du Castel advises at the time of the eruption injections of ether morning and evening; during the day a solution containing 2 or 3 grains of the extract of opium is to be given in divided doses.

Kinyoun, Lundmann, and Bécclère have used the serum from vaccinated subjects (human beings and the lower animals) or from variolous patients in advanced stages of the disease in the treatment of small-pox. The cases, however, are insufficient to warrant deductions.

Special Methods of External Medication.—Talamon recommends a mercuric chlorid spray for small-pox vesicles and pustules as follows:

R. Hydrarg. chlor. corros.,
 Acidi tartarici, āā gr. xx (1.3);
 Alcoholis, fʒij (8.0);
 Ætheris, q. s. ad fʒij (60.0).—M.
 Sig. Use as directed four times daily. ("Poison" label.)

It is essential to exercise the precaution to protect the eyes, which may be covered by layers of cotton dipped into a saturated solution of boric acid. Talamon advises the commencement of this method on the first day of the eruption, the application to be preceded with a vigorous washing of the face with soap, which may be rinsed off with boric acid and then dried with absorbent cotton. After the spray has been used the face should be covered with a layer of a 50 per cent. glycerolate of mercuric chlorid in order to keep the skin continuously aseptic. After the fourth day the number of sprayings per diem is gradually lessened, so that by the seventh day they may be discontinued; but the application of the glycerolate should be continued.

Talamon added, in the confluent and other grave forms of the disease, general mercuric chlorid baths, lasting for three-quarters of an hour to an hour. The buccal and pharyngeal eruption is to be treated by gargles and lotions of boric acid.

Convalescence.—A furfuraceous desquamation may persist for some time; it is to be treated by applications of oils containing some disinfectant. Convalescence is not established until desquamation ceases.

VACCINATION

Historic Note.—One of the first steps in preventive medicine was the practice of inoculation as a method of protection against the infection of small-pox. It had been practised in China and other Asiatic countries for centuries, and Lady Montague, the wife of an English ambassador to Turkey, early in the eighteenth century introduced it into England, after which time and until vaccination was known, it was very extensively practised there. Pus taken directly from a small-pox pustule was introduced beneath the epidermis, and the person inoculated developed variola of a mild form.

The objections to this method were that it did not always produce a mild form of variola, a small percentage of cases having a fatal termination, and that, however mild the attack, other unprotected persons brought in contact with it were as liable to contract virulent small-pox.

In a paper published in 1798 Edward Jenner, a physician of Gloucestershire, England, and a pupil of John Hunter, first made known to the world the value of vaccination. Twenty years previous he had observed that persons employed in dairies, who were accidentally inoculated with cow-pox were insusceptible to the contagion of small-pox, and, after experimenting all these years, he became satisfied that inoculation with the vaccine lymph was preventive against small-pox. After the publication of his paper he was subjected to ridicule and abuse by the profession, but through his persistence he was finally allowed to practice his method of vaccination in the wards of a hospital, and in the course of a few years it became generally recognized and was practised in France and America, as well as in England. Later, the method fell into disrepute for a time owing to the fact that certain persons who had been vaccinated subsequently contracted the disease, it not being known then that a revaccination was necessary from time to time. At present it is generally held that successful vaccination imposes almost complete immunity against variola.

Vaccinia, or **cow-pox**, is a mild eruptive disease that occasionally occurs among cattle, a similar disease being produced in them by inoculation with the small-pox virus from man. It is communicable by contact only, and is usually carried from one cow to another by the hands of the milkers; hence being usually found on the udder or teats of milch cows. Since Jenner's time many theories have been advanced as to the exact nature of this disease in cattle, and at the present day the subject is still in dispute. It is now, however, generally conceded that if cow-pox is a distinct disease, originating only with the cow, the eruptive disease produced in this animal either by inoculation of small-pox virus from man or of "grease" from the horse is, at least in all essential respects, a disease not to be distinguished from primary or idiopathic vaccinia. Guarnieri has described certain parasitic organisms, the *Cytorrhycles variolæ seu vacciniæ*, found in corneal lesions produced by the injection of vaccine lymph. This observation has been confirmed by Pfeiffer and others, but the pathogenic nature of these protozoa has not been determined.

The *vaccine virus* consists of the liquid contained in the vesicle. It is prepared by cureting the six-day-old vesicles on a "sown" calf's abdomen, then collecting the lymph, which is ground in a special mill, thoroughly mixed with glycerin, and preserved for several weeks to ripen. If kept in a cool place the glycerinated lymph retains its virtue for many months or possibly longer, but should not be used after three months have elapsed. It is preserved in capillary glass tubes, sealed at both ends, or between glasses, or ivory or glass points, coated with lymph, are placed in sealed glass tubes.

Dried ivory or glass points, formerly widely used, are forbidden to be employed by an Act of Congress (1910) on account of the dangers of infection. It is impossible by the ordinary methods of preparing lymph to secure a preparation which is bacteria free. For this reason glycerin is added in order to destroy the bacteria, as nearly as possible, through dehydration. A true bacteria-free vaccine has been produced recently by Noguchi, who injected a virus free of spore-bearing bacteria into the testes of rabbits, and at the end of the fourth day excised the testicle and mixed the ground pulp with 50 per cent. glycerin.

The Site.—The point usually chosen for vaccination is on the arm over the insertion of the deltoid muscle; but in girls, for cosmetic reasons, it is sometimes preferred on the leg, and the most common site is over the junction of the two heads of the gastrocnemius muscle.

Technic in Vaccination.—After the part selected has been rendered surgically clean, gently scrape the skin with an aseptic lancet or other instrument until serum begins to exude. The scarification should be in one direction only. Cross scarification is more likely to cause secondary infections, particularly tetanus, and on account of this possibility it has been forbidden by law in Germany. If by too vigorous scraping more than a small amount of blood should be drawn, it must be carefully dried with a piece of sterile cotton before the lymph is applied. Recently the subcuticular administration of vaccine by hypodermic has been recommended because of the rapidity with which a large number of vaccinations can be done and because of the freedom from secondary infection.

The charged end of a vaccine point, covered with glycerinated virus and protected by a thick covering of paraffin, is now gently rubbed over the abraded spot and the limb left exposed to the air until the lymph has been dried upon it. It may then be protected by a piece of gauze strapped on it. I. Dyer advises the breaking of the vesicle and treating the site antiseptically, thus avoiding the proverbial "sore arm" and minimizing the resulting scar. *Humanized lymph* is still preferred by some, in which case "arm-to-arm" vaccination is best. The lymph is taken from a characteristic vaccine vesicle (from the fifth to the seventh day) of a healthy child and applied directly to the arm of another. The virus may be dried and preserved for use as in the case of bovine virus.

The *scab* resulting from a vaccine vesicle on a healthy child was formerly quite generally used, and it could be kept a long time without losing its virtue. It was sure in its action, but it was more liable to become infected than the lymph when preserved in the usual way, and, since the vaccine farms are so conveniently located, lymph may be obtained from them at any time without delay. The possible danger of conveying syphilis from one person to another by means of humanized lymph should lead to its abandonment. In recent years, however, bovine virus has been shown to be occasionally infected with tetanus, and that implantation of the tetanus germs during vaccination may occur.

Period of Life for Vaccination.—It is usually advised to vaccinate infants within a few weeks or months after birth; but unless small-pox is prevalent, it is best to wait until the latter part of the second or the beginning of the third year, as the child has then passed through its teething period and will be better able to resist the effects (slight though they may be) consequent upon vaccination. Kerley advises vaccination at five months, or before the teething period. If an epidemic be prevailing, vaccination should be performed during the first week or even the first day after birth; and pregnant women should receive prompt vaccination at any period of gestation if exposed to small-pox.

Time for Revaccination.—To ensure the individual against infection he should be revaccinated at puberty and at any time when small-pox is epidemic or is liable to become so.

H. A. Gins, however, states that immunity begins to dwindle from the thirtieth year onward, and after the fortieth year only about one-third are still protected, and those only partially.

Symptoms.—After vaccination no local or constitutional effects—except the slight irritation due to scarification—are noticed until the third day, rarely as late as the fifth or even sixth day, when a *small red papule* appears. By the fifth or sixth day a *vesicle* appears. By the ninth day it is fully developed, and, like the vesicle of variola, is filled with colorless lymph, is umbilicated, multilocular, and has a distinctly inflamed areola of deep red color, accompanied by heat, itching, and tenderness. By the tenth day this may extend an inch or two from the vesicle. Quite frequently the axillary or inguinal glands (depending upon the location of vaccination) are swollen and tender, and in a tuberculous child they may go on to suppuration. After the tenth day all these symptoms gradually decline; the *pustule* dries up, and then forms a brown scab which is usually detached in the third or fourth week, leaving a permanent cicatrix. The course is more rapid in revaccinations. Force and Stevens¹ point out that the so-called immediate reaction following a revaccination should be regarded as successful vaccination.

Complications.—Occasionally one or more additional vesicles are formed at a little distance from the point of inoculation, and, rarely, there is a general vesicular eruption, due to absorption of the lymph. An *erythematous rash* about the sixth day is not uncommon. *Erysipelas* may occur as a complication, and, if it is prevalent in the house, vaccination should as a rule, not be performed. Among other rare complications are tetanus (*vide* p. 303) and the hemorrhagic diathesis.

An ulcer may form which may be weeks in healing. Sexton noted marked improvement from the constant local application of antistreptococcus serum. *Eczema* and other skin affections are usually aggravated during the course of vaccination, and it is possible for syphilis to be inoculated with the vaccine virus. Any of these complications call for the usual treatment.

VARICELLA

(*Chicken-pox*)

Definition.—An acute, contagious disease, characterized by a cutaneous eruption of papules, passing into vesicles and pustules; also by slight fever and mild constitutional symptoms. For a long time it was confounded with varioloid, but its distinct character has now been recognized for many years. Complications and sequelæ are infrequent.

Etiology.—The virus is not transmitted by the inoculation of the vesicle contents, as a rule, although it has rarely been thus communicated. The specific poison has not been satisfactorily isolated, but it is suspected that certain protozoa are the direct cause. Positive proof, however, is wanting. Varicella may be transmitted by exposure to another case or possibly through the medium of a third person, the school and asylum being the most frequent points of its origin. It affects children of all ages, and usually one attack is protective. Doty and others have observed varicella in the adult. It closely resembles measles in its contagiousness.

Symptoms.—The *incubation period* is uniformly from fourteen to sixteen

¹ *Jour. Lab. and Clin. Med.*, 1918, iii, 220.

days. If there be a prodromal stage of the disease, certainly in the vast majority of cases it cannot be recognized, though a slight *fever* and general indisposition may be noticed for twenty-four hours before the appearance of the eruption. In many cases the *eruption* is the first symptom. This occurs in the form of small reddish puncta, from which rapidly develop rose-colored maculations, and these become densely distended, transparent, or slightly yellowish vesicles of the average size of a split pea. The eruption *appears first* upon the upper part of the body, the chest and back, neck, scalp, and face (on the latter quite sparingly), and always upon the hairy scalp. Frequently the *vesicles* form on the mucous surface of the lips, inside the cheeks, on the tongue, palate, conjunctivæ, and in the progenital regions of both sexes. At times the glands of the throat become slightly enlarged and painful, the vesicles are superficial, the child has the appearance of having received a shower of boiling water, and the firm papule which precedes the variolous rash is altogether wanting. The vesicles are at first transparent, and their contents plainly show through their translucent roof-wall which is composed only of the stratum corneum of the epidermis. The contents of the vesicles become lactescent, and gradually seropurulent. The *areola* is most distinct when the vesicle is fully formed and fades as the latter dries. Desiccation begins at the apex of the vesicles. *Crusts* form, which drop off in from five to twenty days, depending upon the depth to which the skin has been involved. On the trunk, as a rule, no mark is left, but after the more severe attacks, when the true skin has been involved, scars remain, and frequently there is quite deep *pitting*. The marks are usually on the face when the skin has been unprotected. On the hands and feet the vesicles appear without having been preceded by a papule, and sometimes there is no areola, each vesicle resembling a drop of water upon a healthy skin. *Pustules* may develop in consequence of irritation or infection, as the result of scratching, or in feeble or poorly nourished children, and in unhealthy children, deep ulceration may occur, lasting for weeks.

In *mild cases* only ten, twenty, or thirty spots may be found on the body, but in severe cases the skin may be almost covered in certain regions. The eruption, however, is never confluent. The *temperature* is highest on the second or third day, when the eruption is appearing. In mild, uncomplicated cases the thermometer registers 101° or 102° F. (38.3°–38.8° C.) for two or three days at most, but in severe cases the temperature may be as high as 104° F. (40° C.). This is usually due to broken health prior to the acute illness. The temperature falls *gradually* as the rash fades, and presents a temperature-curve similar to that of measles.

There is usually neither coryza, cough, vomiting, nor diarrhea.

Complications.—*Erysipelas* occasionally acts as a serious complication in delicate children. It may develop about the pocks, particularly when they are deep and associated with some ulceration, and scratching with unclean fingers is its prime causal factor. In rare cases there may be necrotic inflammation about the site of the pox (*varicella gangrænosa*). *Adenitis*, mild and isolated, and *suppuration* in the deeper cellular tissue may occur.

Nephritis is infrequent, but may occur in carelessly managed cases. L. Ceof has collected 40 cases of nephritis complicating varicella.

Varicella is also quite frequently complicated with other infectious diseases, and varicella, scarlet fever, and measles have been seen curiously blended in epidemic form. Ceof has reviewed the literature and found 40 cases of scarlatiniform eruption occurring in varicella. Varicella and measles, however are more commonly associated. The association of chicken-pox with herpes zoster is seen at times. Goldberg and Francis¹ report 3 such cases seen

¹ *Jour. Amer. Med. Assoc.*, 1918, lxx, 1061.

SCARLET FEVER

(Scarlet Rash; Scarlatina)

Definition.—Scarlet fever, or scarlatina, is a self-limiting, acute, contagious disease, characterized by vomiting, fever (more or less typical), angina, and in twelve or twenty-four hours by a diffuse, punctiform, scarlet eruption, followed by membranous desquamation and, frequently, by nephritis. It is a disease of childhood, but may occur at any time of life.

Scarlatina is a wide-spread disease, though perhaps less universal than measles. It is endemic in all the large cities of the globe, and at intervals becomes epidemic. Smaller towns and rural districts are visited, and the epidemics are usually traceable to importation of scarlatinal poison.

Pathology.—There are no pathognomonic changes. When death occurs early the chief lesions are presented by the throat, while in addition, engorgement of the viscera is noted, especially of the brain. The exanthem is rarely visible. In malignant types, however, in which the eruption is not seen during life, it makes its appearance rarely after death, and this aids in establishing the nature of the affection.

When death occurs at an advanced stage the lesions are those either of nephritis (with dropsy), or of septicopyemia, or of inflammation of one or more of the serous surfaces (pleurisy, pericarditis, endocarditis, meningitis, etc.). Of 355 cases of scarlet fever in soldiers, De Massary¹ found nothing to suggest that either the endocardium or pericardium had been affected. Additional changes in the various viscera are, for the most part, identical with those met with in other acute infective diseases. Stegemann believes that the heart weakness in severe toxic cases lies in pathologic lesions in the heart ganglia. The blood is dark, fluid, and coagulates freely, owing to a decrease in its fibrin factors.

Among other lesions which are more or less peculiar to the disease are: (a) The *eruption*, which is a dermatitis of very mild grade. J. F. Schamberg points out that the discrete vesicles sometimes seen originate in the hair-follicles or in the deeper layers of the *rete*, and contain a turbid leukocytic fluid. (b) *Scarlatinal angina*, which in its mildest form presents hyperemia of the mucosa of the tonsils, soft palate, and pharynx. In the severer grades the inflammation is phlegmonous (*scarlatina anginosa*), and sometimes terminates in ulceration. There is great swelling (especially of the tonsils), and the formation of abscesses is common. Extension of the purulent inflammation to the connective tissue of the neck produces marked induration, and more or less extensive abscesses may take place. Gangrene sometimes supervenes. (c) In certain epidemics a *membranous exudate* accompanies the *scarlatinal angina*. When it appears early it is non-diphtheritic, as a rule, and often due to the streptococcus; on the other hand, when it comes on late it often shows the presence of the Löffler bacillus. Schabad has, however, shown that bacilli taken from the throats of incipient cases, although morphologically characteristic, have little or no virulence. There is also a malignant form of membranous scarlatinal angina, occasioned by a secondary streptococcic infection (Hirschfeld). (d) *The Nephritis.*—The renal lesions are included in the description of Acute Bright's Disease.

Etiology.—The **bacteriology** of the affection is imperfectly known. The *Streptococcus pyogenes* has been found in nearly all the inflammatory complications of the disease, especially scarlatinal pneumonia and angina, and some pathologists (Babés, Bergé, Klein) have held it to be the cause.

¹ *Jour. Amer. Med. Assoc.*, May 18, 1918, p. 1506.

Raskin and Mosny, however, believe that it is an example of mixed infection, the streptococcus being merely a secondary factor.

W. J. Class first described an organism (*Diplococcus scarlatinæ*). His researches have been confirmed by those of Gradwohl, Jacques, Page, and others. The habitat of the diplococcus is not known, but it has been found in the blood, throat, epidermal scales, and urine of scarlatinal cases. The size of the organism is variable, and it stains with standard watery dyes easily, uniformly, and regularly (Gradwohl). Class reports on his experiments to obtain an *antitoxin* for *Diplococcus scarlatinæ*, in which he was successful. Sommerfield has found the constant presence of streptococci in the tissues and blood. This may be the same organism as the Class coccus.

Mallory and Medlar¹ have isolated a strongly Gram-positive bacillus (*Bacillus scarlatinæ*) which they feel assured is the causative agent of scarlet fever. It is found after the skin eruption appears, usually in the tonsils or at the root of the tongue. The desquamative material from the skin is not infectious, but the secretions from the nose and mouth are. Vipond claims to have found a bacillus in the enlarged axillary and inguinal lymphatics. Pryer and Kelly² found in 19 out of 24 cases a diphtheroid organism in pure culture.

The *receptivity* for scarlet fever is not so great as in certain other exanthemata (*e. g.*, measles); hence in a household in which there are several children, some are apt to escape the disease, even though all have been equally exposed. The *virus* is probably contained in the excretions from the *throat, nose, or ear*, and in the epidermal scales thrown off from the surface of the body. It is also present in the blood.

Modes of Conveyance.—(a) The majority of the cases are produced by *contagion*, and I have observed that a single contact of a healthy child with a scarlet fever patient suffices. The disease may also be transferred by persons who have been in the sick-room, while they themselves escape. Aaser found, out of 3800 cases, 79 had been infected by discharged hospital patients from one to five weeks after cessation of desquamation ("return cases"). The source of infection in these cases is an abnormal secretion due to some local affection of throat, nose, or ear associated with discharge. (b) It is also communicated by *fomites*, and the poison of scarlatina contained in clothing retains its infective power for months. Again, any objects (furniture, utensils, library books, toys) which the patient has handled may serve to communicate the poison. (c) Infected dairies have been known to disseminate the poison and give rise to epidemics. (d) The infection may also be air-borne, though not for any great distance. (e) Behle reports an outbreak of human scarlatina in swine; and kine are potent to transmit it to man.

Mode of Infection.—Most probably the poison is inhaled into the throat, where infection usually occurs; but it may gain entrance to the body through the *alimentary tract*. Infection may also take place *through the blood*, as is shown by the fact that children have been born in all stages of the disease. Artificial inoculation with the blood of scarlatina patients has resulted in more or less typical forms of the complaint. *Open lesions* predispose, but whether they are essential to infection is not known.

Predisposing Causes.—(1) *Age*.—The period of chief liability is from the second to the tenth year, after which it diminishes. In a period of eight years over 166,000 persons were treated for scarlet fever in the Metropolitan Asylums Board Hospital, of whom only 11 were over sixty years of age. It is rare under the age of one year, and especially so under six months. Dublin³

¹ *Jour. Med. Research*, March, 1916.

² *Jour. Lab. and Clin. Med.*, February, 1918, p. 269.

³ *Jour. Amer. Med. Assoc.*, May 27, 1916, p. 1667.

analyzed 1153 cases and found that 92 per cent. of deaths occurred in children under ten years. (2) *Recent wounds*—accidental or surgical—increase the susceptibility to the peculiar poison. (3) *Women in childbed*, for the same reason as (2); but care must be exercised lest this class be confounded with septic affections. (4) *Season*.—The autumn and winter months furnish the most cases. Dublin's statistics indicate that with the opening of schools in September the number of cases begins to increase rapidly, reaching the maximum in the spring. (5) Seitz believes there is evidence of a *family predisposition*, as 371 out of 800 cases occurred in 152 families.

Immunity.—Single attacks during the life of a person form a rule to which there are rather frequent exceptions.

Clinical History.—The **incubation period** is variable, lasting, on the average, from ten to fourteen days (McCollam). It may rarely, however, be longer, although more commonly a briefer period, three to eight days.

The **invasion** of scarlet fever is generally quite *sudden* and, as a rule, active. The child feels uncomfortable, looks stupid, complains of *sore throat* and decided nausea, and in the great majority of the cases *vomits*. The tongue is furred. If he be very young, *nervous symptoms* are prominent, and the initial symptom may be a convulsion. The *pulse*, which is a strong diagnostic factor, is rapid and hard, reaching 140 to 160 at the very onset. The *temperature* rises quickly to 104° or 105° F. (40°–40.5° C.), and remains high.

Eruption.—Within the first twenty-four or thirty-six hours the characteristic rash appears, and is as a rule, first seen on the neck; there is no certainty about this, however, as it may first come out on the abdomen or back of the hands or on the thighs, and not be seen on any other part of the body. Frequently it is found on the dependent portions of the trunk. At first it is slight, but perfectly characteristic, and usually takes two days to mature. In mild cases it disappears within thirty-six to forty-eight hours, and at no time is more than a very fine rash, but when typical it cannot be mistaken, especially if accompanied by the premonitory symptoms. When seen from a short distance at the end of the first twenty-four hours of its appearance the whole body (except the face) is of a uniform bright scarlet color. If we examine more closely, we find that the eruption consists of a multitude of red points (*puncta*) that correspond to the hair-follicles. These points are surrounded by zones of erythematous redness, which, joining with one another, give a generally diffuse red appearance to the whole skin. Frequently, however, the rash consists of points representing the hair-follicles without the erythema, and in rough skins the rash may be more punctiform—that is, more strictly a condition of “goose skin.” Sudamina are quite frequent. Pressure by the finger causes a pallor which at once disappears when the finger is removed. The patient's lips and chin are pale and in striking contrast with the vividly scarlet cheeks. In some cases the rash is patchy, especially on the limbs, and in these cases it may suggest measles, the patches consisting of clusters of fine papules or points with much surrounding erythema, while normal skin is present between the patches. An intense continuous linear exanthem in the skin folds at the bend of the elbow (Pastia's sign) is supposed to be proof of scarlet fever. In severe cases the rash may be hemorrhagic in character, minute extravasations of blood taking place in the skin; this may occur even in mild attacks, and not be seen until after death, but more frequently it is seen in malignant cases. Purpuric patches are frequently found after death, when even in life they do not appear. There is itching, which may be intense.

The rash is succeeded by a *desquamation* that will be extensive or slight according to the intensity of the fever. In *mild cases* the tonsils, palate, uvula, and pharynx are deeply congested, and the mucosa of the cheeks,

palate, and tonsils may show the eruption. In *severer forms* the tonsils are red and inflamed, and covered with tenacious secretions, while minute yellow points corresponding to the tonsillar crypts are usually prominent. (*Vide* Malignant Scarlatina.) The nasal chambers are swollen, producing a free discharge, and the deeper cervical glands at the angle of the jaw are frequently enlarged. The *tongue* is coated with a thick, dense white fur (dead epithelium), and frequently shows a dry, glazed central band. In a few days the dead epithelium is cast off, clearing the tongue, when we have a red, clean, glazed tongue with greatly enlarged fungiform papillæ, giving us the *strawberry tongue* of classical history. The eyes are frequently swollen and the conjunctivæ injected. *Sleeplessness* and *mild delirium* often mark a typical case, suggesting a congested state of the meninges, but it is neither usual for the child to be violent nor for the delirium to continue long.

Fig. 17.—Temperature-curve of a case of scarlatina with favorable course—William C——, aged seven years.

The *pulse* is usually a strong diagnostic feature, and is always hard, quick, and wiry, varying from 140 to 160; its rate is out of proportion to the temperature and the general condition of the child. *Leukocytosis* is noted; it develops early and is most marked in cases showing suppurative lesions. This leukocytosis is a true one, *i. e.*, an increase absolute and relative in the polymorphonuclear cells. With the onset of defervescence there is a constant eosinophilia (Tileston and Locke). The *temperature* in average cases reaches 104° or 105° F. (40°–40.5° C.), and in severe forms it may touch 106° F. (41.1° C.), the nocturnal remissions being slight and defervescence gradual (Fig. 17). The *urine* is scanty, thick, and contains urates, with a small quantity of albumin.

Within one week, if no complications have occurred, the attack will have reached its height and the symptoms have begun to decline. The rash gradu-

ally fades, temperature falls, the tongue is less red, the throat less injected, and the child seems more natural. If at the end of one week the fever continues, it suggests one of the many possible complications, the most frequent of which are a throat or tonsillar ulceration, inflammation of the cervical glands, otitis, or acute nephritis (common). It must be well understood that no two cases of scarlet fever are alike. Molchanoff and Lebedeff found that among 10 scarlet fever patients, 8 were vagotonics during convalescence, as manifested by retardation of pulse, arrhythmia, dilatation of heart, and certain blood changes (eosinophilia). In all the 10 patients there were signs of increased tonus of the sympathetic nervous system, *e. g.*, white or negative dermographism.

Clinical Types.—Mild Scarlet Fever.—The premonitory symptoms are sometimes absent, the rash being the only indication of the complaint. There is neither vomiting nor fever to be recognized, and no tonsillar trouble of any importance, while the rash is neither uniform nor well marked. In these cases we must be very careful not to confound the eruption with urticaria or some of the many medicinal rashes.

During house epidemics when several children are affected it frequently happens that a child has sore throat and the "strawberry tongue" without a development of the rash. This may also occur in adults, and is the so-called *scarlatina sine eruptione*. These very slight cases of the fever may be followed by the most severe attack of nephritis.

Here may be mentioned the so-called *fourth disease*, in which the symptoms are said to resemble both German measles and mild scarlet fever and yet to be unlike either. It is to be recollected that "the symptoms may be caused by the poisons of both these affections acting simultaneously" (Dent).

Traumatic scarlatina is that form in which infection occurs in a wound. The eruption makes its appearance at the wound, and then spreads over the body; it is less severe in its course than ordinary scarlatina.

Malignant Scarlet Fever.—Death occurs usually by the end of the first week in severe cases, Drs. Ashby and Wright reporting a death within the first twenty-four hours (*atactic form*). In malignant cases such as usually occur among the unhygienic and delicate, the tonsils may be covered by a membranous exudate, and the system quickly receive an overwhelming dose of the poison; death then results from septic causes (*anginose form*). In cases in which death occurs early a child soon becomes cyanotic, restless, or more frequently somnolent. In all these cases the temperature remains high—105° to 106° F. (40.5°–41.1° C.), and very frequently 107° F. (41.6° C.). Diarrhea is frequently a troublesome factor in severe cases; coryza is very abundant; there is much glandular swelling and cellulitis, the neck becoming enormously enlarged and hard, the skin dull and livid in color; the extremities grow cold; the heart gradually becomes irregular, losing a beat, and finally fails.

If life is sustained through such an ordeal, the tonsils slough and the lungs may eventually become the seat of a septic pneumonia. General septicemia is most likely to occur. In this condition the tonsils ulcerate, sloughing patches appear on the fauces, the glands about the neck become enlarged and doughy, and the nasal mucous membrane gives out a purulent secretion in abundance. The temperature may remit, but continues high; the urine is albuminous; pus wells from both ears; and thus the child gradually perishes.

A third variety (*hemorrhagic*) shows at first cutaneous petechiæ which grow rapidly into large ecchymotic patches. Hemorrhages also take place from the mucous surfaces, epistaxis and hematuria being very common. Death, as a rule, follows in two or three days.

Desquamation.—By the end of the first week the rash commences to dis-

arcely any blood and but few casts. No renal symptoms will be recognized, and if present they may be masked by the general condition of septicemia. There may be neither dropsy nor uremic phenomena, but the patient usually dies by the end of the second week, when a typical pyemic kidney is found containing minute abscesses. This condition of the kidney is only one part of the general pyemia, and merely illustrates the fact that this organ suffers during the course of the general inflammation.

(b) *Glomerulonephritis*.—The kidneys are undoubtedly involved in an acute sympathetic inflammation, and at the end of the fever, more than at the beginning, are engaged in carrying off waste products of the fever itself. From the nature of the disease they are in an irritable condition and prone to take on inflammatory changes, just as the bronchial tubes and the lungs are left in a very susceptible condition following measles and whooping-cough. In this way the uriniferous tubules become choked up by the desquamation that is going on inside. The *number of cases* that suffer from post-scarlatinal nephritis varies according to social conditions, the nature of the epidemic, the season of the year, the nature of the treatment received during the disease, and especially the care received throughout convalescence. Ashby and Wright fix the rate of those who suffer at 6 per cent. of hospital cases, but this is, undoubtedly, too high, since hospital cases receive excellent care during convalescence as a rule. The usual *time* for this form of nephritis to occur is from the end of the second up to the fourth week, but it usually begins very insidiously. Traces of albumin may be found for a few days before the blood and larger quantities of albumin occur, but it is often impossible to date the commencement of an attack. If the blood-pressure is taken daily as a routine, a sharp rise in pressure may be the first indication of renal involvement. Usually after the fever has subsided the patient for a few days feels well, but very suddenly grows restless, is feverish at night, is thirsty, has a quick, hard pulse, and passes a small quantity of dark-colored urine. The temperature almost invariably rises again and there is no relation between the pulse and the temperature. If care has been exercised, it will be found that the urine has been gradually diminishing for several days, and a slight puffiness about the face frequently announces the beginning of the trouble. Later the face becomes pale and puffy, while there may be edema of the feet and scrotum and some vomiting. Under favorable treatment improvement may take place, large quantities of urine may be passed, and the child resume convalescence. The nephritic symptoms may, however, deepen until *uremia* appears, the pulse becoming slow and wiry in character, the temperature subnormal, and the tongue dry and brown. Vomiting is now a frequent occurrence; diarrhea is not unusual; nosebleed and hemorrhages from the various mucous surfaces, and muscular twitchings may be noted, and most likely the end may be reached in a general convulsion. After scarlet fever, kneeling for ten minutes in the lordotic position may produce albuminuria. Fatal results, however, are more frequent from *cardiac failure* than from uremic convulsions. The constant effect of nephritis is to raise the blood-tension, followed by dilatation of the heart. Another not unusual result is *endocarditis* or *pericarditis*, with possible embolism.

Sudden death frequently occurs during the course of nephritis. The child may be doing well, possibly sitting up in bed and playing with its toys, when an attack of dyspnea occurs; the face becomes livid, the pulse disappears, and death quickly takes place. Death in such cases is due to a *dilated heart*, followed by edema of the lungs.

It is not unusual for a false membrane to form upon the *larynx*. This is not infrequently due to the *Streptococcus pyogenes*, but the Klebs-Löffler bacillus is often found. A bacterial examination should always be made,

and if the *diphtherial* nature of the infection has been determined the serum treatment should be employed at once.

Diagnosis.—A typical form of scarlet fever offers few difficulties in diagnosis. The period of incubation is short in comparison with that of any of the other exanthemata, particularly variola, measles, and varicella. The vomiting, associated with high fever, would also exclude the other eruptive diseases. The pulse in itself is strongly diagnostic, being quick, hard, and wiry, striking the finger at the rate of 140 to 180 per minute. The early sore throat and the intense hyperemia of the whole mucous membrane, associated with marked constitutional symptoms, make it easy to differentiate from measles, varicella, and variola. Leukocytosis occurs in this disease, but is not present in measles or varicella. Tunnichoff¹ calls attention to the fact that mild cases of scarlet fever frequently resemble rubella. In the former condition, however, there is a leukocytosis, and throat smears show many polymorphonuclears together with a variable number of cocci, usually round, in pairs or chains of not more than four. In rubella the throat smears show many epithelial cells and very characteristic diplococci on the epithelial cells. Döhle² discovered certain inclusion bodies in the polymorphonuclear leukocytes from scarlatinal blood prior to the sixth day. This view is confirmed by Granger and Pole, but Bongartz and others state that it is not possible to consider the inclusion bodies pathognomonic for any one disease. The punctate eruption of scarlet fever is not found in any of the other eruptive diseases (*vide* table on page 215). If a child has never had scarlatina and the characteristic symptoms are present, a rapidly growing culture (taken from the throat) of the class coccus from such a case determines the presence of scarlet fever, while its absence excludes the disease (Jacques).

The DIFFERENTIAL DIAGNOSIS embraces the discrimination of those rashes that follow the use of certain drugs (quinin, belladonna, potassium bromid and iodid, chloral, etc.). The characteristic invasion-symptoms (vomiting, angina, etc.) of scarlatina are absent; also the high fever and frequent hard pulse of the latter disease. *Drug rashes* are seldom so vivid or diffuse as the eruption of scarlatina.

SCARLATINA	ACUTE EXFOLIATIVE DERMATITIS
Onset is sudden, with vomiting, angina, fever, and frequent, hard pulse.	Sudden, with fever only.
Eruption appears first on neck, face, and chest, soon becoming diffuse.	Appears first on trunk.
Duration, three or four days.	Duration, five or six days.
Desquamation begins after eruption has faded, often one week later.	Desquamation begins earlier, often before eruption has faded, and involves the hair and nails.
Ear and throat complications common.	Absent.
Nephritis is a common sequel.	Not so.
Relapses exceptional.	Relapses common.

The combination of leukocytosis and eosinophilia will permit the exclusion of *simple infectious sore throat*.

The **prognosis** in regular, uncomplicated scarlet fever is almost always favorable, and, unless the treatment is unusually indifferent, the patient will recover. Severe types, however, and especially malignant scarlatina are very fatal. Complications arise that will most seriously endanger life. "The death-rate for colored children is about one-fourth that of the whites" (Dublin). Donnally states that scarlet fever appears to be a milder disease than formerly. All writers agree that males succumb more readily to it than

¹ *Jour. Amer. Med. Assoc.*, 1918, lxxi, 104.

² *Centralbl. f. Bacteriol.*, November 23, 1911.

females. Age is a potent modifying factor, case fatality being progressively less with each year of life.

The treatment of scarlet fever is that of the symptoms, together with an attempt at arresting the complications.

Prophylaxis.—The patient should be strictly *quarantined* in an upper room for at least eight weeks, or until desquamation has been completed and discharges from the mucous membranes, if any, shall have ceased. Weaver¹ advises gauze masks, and states that since June, 1916, these were worn by the nurses of the Durand Hospital without the occurrence of a single case.

During *convalescence* hematinics are required to overcome the symptomatic anemia and debility. Preisich urges the importance of separating the convalescents from patients in the first stages. A competent nurse should be put in charge, and, whether a member of the family or otherwise, she should wear a washable dress, and should not mingle with the family except her clothing be changed or thoroughly disinfected. The room is to be stripped of all superfluous hangings and furniture. *Inunctions* are required as soon as desquamation commences, with a view to preventing the diffusion of the dried epidermal scales; and the best preparation for this purpose consists of cosmolin, menthol, and carbolic acid, 10 grains each of the latter to 1 ounce of cosmolin after the plan of J. Lewis Smith. Carbolyzed water, 1 : 40, may be used to sponge the surface and may be agreeably followed by cocoa-butter. The nasopharynx must also be kept disinfected.

The *disinfection* of the physician himself is important. He should generate chlorin gas by the following simple method, and allow it to permeate his clothes thoroughly before going into other families: A dram of powdered potassium chlorate is placed in a saucer, and a small quantity of hydrochloric acid added. The dish is then placed on the floor, and the physician stands over the vapor chlorid as it arises until it penetrates all his clothing. This, with the free use of the whisk and thorough hand-washing, renders him non-contagious and safe in entering any home or sick-room. The best method is to have in the patient's house a linen duster or surgeon's apron that has been dipped in a bichlorid solution and allowed to dry. This is slipped over the clothing before entering the sick-room, and is removed after leaving.

In the room, if the case be a severe one involving the throat, I keep the gas or an alcohol lamp burning under a small dish of water, so that steam is constantly generated. To the boiling water I frequently add carbolic acid or oil of eucalyptus; this saturates the room very pleasantly.

General Management.—The sick-room should be large and well ventilated, and should be kept at a uniform temperature (68° to 70° F.—20°–21.1° C.). A light flannel night-dress should be worn by the child, and the bedclothing should be light as well. The *diet* should consist of milk, egg-white, and fruit juices, and after the temperature has declined soft diet may be allowed. J. McCrae insists upon twenty-one days' milk diet. A return to ordinary solid foods, especially proteins, must be made gradually during convalescence.

The evidences of heart enfeeblement often arise and call for the judicious use of stimulants. This class of agents is remarkably well borne in this affection. To a child of four years I give 1 dram (4. 0) of brandy or whisky every second hour, and often increase the dose as required. The preparations of ammonium, particularly the carbonate and the aromatic spirits, have also been warmly recommended. They should be administered in milk as the vehicle to prevent gastric irritation. Heart failure is best treated by baths at 90° to 95° F. and oxygen inhalations (Ausset).

Special Treatment.—In the classical work of Thomas Watson, now over fifty years old, he hints in his treatment of scarlet fever "that, if the heat on the

¹ *Jour. Infect. Dis.*, 1919, xxiv, 218.

Scarlatinal synovitis I have encountered in but a small proportion of cases, and then it was of a transient character. I am inclined to attribute this fortunate result to the faithful use of daily bathing and inunctions, long continued and at least until after completion of desquamation.

The specific poison of scarlet fever is peculiarly obnoxious to the kidneys, and is largely eliminated through them; and upon this fact hinges the scientific part of the treatment of this disease. Free bathing has the happy effect of vicariously eliminating the poison in a measure at least. In post-scarlatinal uremia venesection supplemented by saline infusion produces excellent results. (For the treatment of nephritis, see Diseases of the Kidneys, p. 977).

Specific Therapy.—Marmorek, and later Charlton, has used the *anti-streptococcic serum* extensively, and, although it does not act as a specific, it prevents the serious complications and invariably renders the attack mild. Moser, of Vienna, has discovered a new serum which has given good results in a series of 400 cases. Koch and others recommend a mixed serum from the blood of scarlet fever convalescents, especially in severe toxic cases. Reiss and Hertz¹ recommend the early intravenous injection of mixed serum (50 c.c. for children and 100 c.c. for adults) from scarlet fever convalescents, especially in the severer toxic forms. Zingher² reports favorable results from injecting the whole blood from convalescents (from 75 to 250 c.c. daily) before toxemia is overwhelming. A syringe-ful (1 ounce) of blood is injected into the following muscles: the gluteal regions, the outer regions of the thighs, the calves, and the triceps muscles.

FOURTH DISEASE

(*Dukes' Disease*)

This complaint was first described by Clement Dukes in 1900. The so-called "fourth disease" resembles both German measles and mild scarlatina. The *etiology* is obscure. The incubation period is from one to three weeks, usually fourteen or fifteen days, and the time of transmissibility ranges from two to three weeks. *Prodromata* are often absent, though a slight febrile movement may precede the eruption by from six to twenty-four hours.

Cotton states that catarrhal symptoms of the faucial, oral, or ocular mucosa may rarely be present. Usually the postcervical and occipital lymph-nodes are palpable early in the attack. The *eruption*, which resembles that of scarlatina, appears first on the face or neck and spreads downward, quickly covering the trunk and portions of the extremities. Itching is absent, and the rash fades rapidly after two or three days without stain.

A fine, branny desquamation follows the disappearance of the eruption. The pulse is accelerated in proportion to the febrile movement, which is marked, but lasts only two or three days. Complications are rare, while sequelae rarely occur.

The *discrimination* of Dukes' disease from scarlatina is made with readiness by noting the absence of vomiting, of a pulse-rate out of proportion to the fever, the strawberry tongue, lamellar desquamation, and of the characteristic oronasal pallor. In *rubella* the rash is light in color and presents patches of irregular shape (*vide* p. 217). Corlett and Cole³ state that aberrant forms of scarlatina should not be regarded as distinct affections, and that the consensus of opinion does not substantiate the claim for a fourth disease.

The *prognosis* is favorable and *treatment* that of mild scarlatina.

¹ *Munch. med. Wchnschr.*, 1915, lxii, 1177.

² *New York State Jour. Med.*, 1916, xvi, 112.

³ *Jour. Amer. Med. Assoc.*, July 16, 1910.

MEASLES

Definition.—An acute contagious disease, characterized by an initial coryza, general catarrhal symptoms, fever in the earlier stage, followed by a peculiar papular eruption on the face and body.

Pathology.—In uncomplicated measles we have no pathologic lesions. The only postmortem changes found, as a rule, are those of catarrhal pneumonia and acute nephritis. All the internal organs are gorged with blood, and minute hemorrhages are found on their surfaces. The skin presents the following histologic lesions: focal necrosis, with the formation of small vesicles, isolated necrotic epithelia, diffuse perinuclear vacuolation of cells of the epidermis and of the dermal glandular structures, with congestion, edema, swelling, proliferation of the endothelial cells, and a moderate increase of the large round cells (Ewing).

Etiology.—Measles occurs in epidemics, although sporadic cases are common in the larger cities. There is an epidemic prevalence in large centers of population every eighteen months or two years, but the different epidemics vary in their extent and fatality. It generally happens that when once the disease enters a home, street, or small court, scarcely any one escapes who has not been protected by a previous attack. The susceptibility to measles in children is very great, except in the newborn, who seldom contract the disease. Biedert found that only 1½ per cent. of unprotected children escaped. In the Faroe Islands, under similar conditions, only 1 per cent. escaped (Madsen Pannum). There is the same experience in schools and hospitals. The epidemics occur mostly in the fall and winter, yet the season has little influence. The poison is conveyed principally by *contagion*, rarely by *fomites*. Wagener finds nothing to confirm the assumption that measles can be transferred by inanimate objects or by healthy persons. It is contagious as early as five days preceding the appearance of the exanthem, and reaches the height of its infectivity just before the appearance of the eruption.

Bacteriology.—A large number of observations have been made upon various organisms that have been found in cases of measles, but as yet none of these observations have demonstrated any specific organism as the cause of the disease. Perhaps the most conclusive and careful work has been done by Tunnecliff.¹ She found, in addition to the diverse bacteria that occur in measles, that a small Gram-positive anaërobic diplococcus could be isolated very consistently by blood culture just before the rash made its appearance, and that smears from the throat, eyes, and nose, taken early in the attack, uniformly showed this same bacterium. On the other hand, Goldberger and Anderson² claim to have discovered an infective virus. Sellards³ was unable to transmit the disease to apparently susceptible volunteers, though blood from patients sick with measles at varying stages of the disease was injected into them and the nasal and lacrimal secretions were also inoculated upon the oral, nasal, and ocular mucous membranes. Likewise he⁴ concludes from his experimental work with monkeys that the reaction that occurs following the injection of blood from cases of measles in the pre-eruptive and early eruptive stages does not represent a reaction to the virus of measles.

In patients dead of the complicating bronchopneumonia both the influenza bacillus and hemolytic streptococci have been isolated. During the recent epidemic of measles in the cantonments hemolytic streptococcus has been

¹ *Jour. Infect. Dis.*, 1918, xxii, 462.

² *Jour. Amer. Med. Assoc.*, September 16, 1911.

³ *Bull. Johns Hopkins Hosp.*, 1919, xxx, p. 257.

⁴ *Ibid.*, p. 311.

found to be responsible chiefly for the bronchopneumonia which caused so many deaths. Cole found it in the 30 cases he examined in the sputum coughed up from the deep respiratory tract. MacCullum found it uniformly in the interstitial bronchopneumonic areas, in the pleural exudate, and in the bronchi of those dying from post-measles bronchopneumonia.

Immunity.—One attack of measles almost always exhausts the soil, but in exceptional instances recurrent attacks may occur.

Clinical History.—The period of incubation is from seven to fourteen days, and in inoculated cases from seven to ten days.

Catarrhal Stage.—The early symptoms are those of a *cold* with some *fever*. The child has marked coryza, watery eyes, sneezes, and has a dry, croupy cough. Frequently the symptoms are those of a *catarrhal laryngitis* and *bronchitis*, the fauces and tonsils being hyperemic, with abundant secretion, and there is conjunctivitis. The patient may be acutely ill, the *temperature* rising several degrees in the evening, and falling slightly in the morning; the fever continues high until the rash is fully developed. The *rash*, consisting of one or more distinct *papules*, may be seen on the hard palate fully twenty-four hours before it appears on the face. A transient prodromal eruption, which may be erythematous, truly scarlatiniform or urticarial, may rarely be observed.

The **eruptive stage** is very characteristic, and usually makes its appearance at the end of the *fourth* day. The neck, face, forehead, and trunk receive the eruption in the order mentioned. The whole physiognomy of the child is so characteristically altered that a well-marked case may be diagnosed at a glance. The face is flushed; the eyes are red and watery; a short, dry cough, frequently metallic in ring, is present; and the nose and cheeks are covered with crops of dusky-red papules surrounded by a zone of erythema which sharply contrasts with the normal skin between the patches. The rash on the face is both *discrete* and *confluent*, or may be arranged at times in small crescents, and in the course of a day or two the whole trunk is invaded, but in a slighter degree. By the fifth, and seldom the sixth day, the eruption has reached its height, and commences to fade, first on the face and neck, then on the body and limbs, followed by a *fine desquamation*. By the seventh or eighth day the rash is nearly gone, leaving a blue, mottled stain over the body. The temperature, which has reached 103° F. (39.4° C.) or even 105° F. (40.5° C.), falls when the rash is fully established—*i. e.*, on the fifth or sixth day—while the headache, the severe cough, and general features also subside with the fever. If the temperature continues high after the rash is out, we may look for some complications, such as pneumonia or acute nephritis (*vide* Fig. 18).

An eruption first described by H. Koplik also occurs on the buccal and labial mucous membrane; it appears “as long as twenty-four hours, forty-eight hours, and even three to five days before the appearance of the skin exanthem.” It is present before the signs of conjunctivitis appear, and when little or no fever is present. It was found in 52 consecutive patients in Koplik’s clinic. This eruption consists of small, irregular spots of a bright red color, and in the center of each red spot is the interesting sign which Koplik has described, a minute, bluish-white speck. To see the latter requires a strong, glaring daylight, and they must be looked for by everting the mucous membrane of the lips and that of the cheeks. The spots may be few, and again they may be quite numerous. Widoweiz and Cotter fail to find the spots in about 10 per cent. of the cases, while Lepit, in an analysis of 327 cases, found them almost always present. Among other writers, J. L. Hirst, C. C. Ross, and Rolly attach great value to Koplik’s sign in the diagnosis.

early sign is usually present and is distinctive. The blood shows an early change in the leukocytic percentages which, in suspected cases, may be taken as the first indication of infection. There is a decrease in the lymphocytes and a relative increase in the polynuclears, but with a total diminution in all forms. The normal picture in an infant of 50 to 70 per cent. of lymphocytes and 25 to 35 per cent. of neutrophils may be reversed in measles. The leukopenia persists during the course of the disease. A feverish period of four days, associated with catarrhal symptoms of the eyes, nose, and upper air-passages, a few papules on the hard palate, followed within twenty-four hours by a papular efflorescence on the face, will differentiate the disease from *variola*, *varicella*, *scarlet fever*, and *rubella*.

The accompanying table from Rotch will aid the discrimination:

	MEASLES.	VARIOLA.	VARICELLA.	SCARLET FEVER.	RUBELLA.
Incubation	10 days.	12 days.	17 days.	4 days.	21 days.
Prodromata	3 days.	3 days.	A few hours.	2 days.	A few hours.
Efflorescence . . .	Papules.	Macules. Papules. Vesicles. Pustules.	Vesicles.	Erythema.	Papules.
Desquamation . .	Furfuraceous.	Large crusts.	Small crusts.	Lamellar.	
Complications and sequelæ	Eye and lung.	Larynx. Lungs.		Kidney, ear, and heart.	

The **mortality** differs according to the surroundings of the patient. In healthy children under favorable environment the mortality is practically *nil*, while in tuberculous and wasted children it is very large, this being especially due to complications and sequelæ. Infants may be born with the rash on them. The disease is quite fatal when it follows other acute infections (*e. g.*, scarlatina). Based upon the annual average mortality for the registration area for the ten-year period 1904–1913, over half of the measles deaths are in infants, and about 90 per cent. in children under ten; the fatality rate reaches its height in the second year of life and maintains a fairly level curve until the sixth year (Veeder).

Treatment.—**Prophylaxis** consists of thorough disinfection and isolation, commencing with the catarrhal stage in all cases in which measles may be reasonably suspected, and also during epidemics. Isolation should be continued for two weeks after the beginning of the eruption. The treatment is necessarily symptomatic; hence our efforts should be directed toward protecting the various organs that are most likely to become involved by complications, remembering at the same time that the nose, ears, eyes, and throat are involved during the feverish stage, and that the skin is in a very susceptible condition.

The patient should be placed in a large, dark, well-ventilated room, with a uniform temperature between 68° and 70° F. (20°–21.1° C.). He should remain in bed until the temperature has been normal for one week, and until the efflorescence has nearly faded and the desquamation is almost complete. The diet during the period of fever should be milk, bread, and light soups. Near the end of desquamation, if all symptoms are favorable, a more generous dietary may be allowed.

In hospitals or where persons are crowded and living under unhygienic circumstances the disease is very *contagious*, though probably less so than measles, and the epidemic will be quite general; but in family practice it is but slightly so, and the epidemics are limited, often being confined to a single household and attacking perhaps but one or two of the family. As compared with measles, the incidence shows a larger percentage of adults. As stated by Edwards, it is spread by the *cutaneous exhalations, breath, fomites, and clothing*, and is probably contagious from the period of incubation until far into convalescence.

Clinical History.—The incubation stage lasts from ten to sixteen days, though this period may vary and the disease appear three or four days after exposure. On the other hand, cases have been reported in which it was as long as twenty-five days. As a rule, the period of incubation is longer perhaps than in measles. The *stage of invasion* covers from one to three days.

For a period of a few days before the rash appears there may be noticed chilliness, pains in different parts of the body, a dull, heavy feeling, perhaps feverishness, sore throat, enlarged tonsils, and a slight bronchitis. Enlargement and induration of the postcervical glands is constant, while the anterior glands are also commonly enlarged.

Just before, or with the appearance of, the rash there is a rise in *temperature* to 99° or 100° F. (37.2°–37.7° C.), or in severe cases as high as 103° F. (39.4° C.) or more. Again, the invasion symptoms may be absent or so mild as to escape notice, and the first sign of infection is the appearance of a *rash* which first shows itself on the face and extends downward over the body. In some cases the eruption does not follow the regular course, and is confined to one part of the body, and cases have been reported in which it only appeared on the roof of the mouth or on the tonsils. In other instances every part of the body, including the palms of the hands and the soles of the feet, may be covered.

The eruption consists of *papules*, is multiform, confluent, and of a pale or rose-red color. The patches do not assume any regular shape or form, and the skin between them may become hyperemic and cause itching. The rash reaches its height on different parts of the body in succession, fading in one part while appearing in another. Its duration is from two to five days, and possibly longer in some cases.

A slight *desquamation* usually occurs, and a slight pigmentation of brownish color after the rash fades is frequently noticed, disappearing after a few days. The *temperature-curve* is variable, but, as a rule, it remains between 100° F. (37.7° C.) and 102° F. (38.8° C.) while the eruption is present. As mentioned above, sore throat is nearly always present, with enlarged tonsils, a dry cough, and bronchitis. The glandular enlargement will also continue with the rash, and in severe cases the axillary and inguinal glands may become involved. The *pulse* varies with the temperature and respiration. Vomiting has been noticed as occurring during the eruption in severe cases.

After a period varying from three days to a week, with the disappearance of the rash, convalescence begins and the child rapidly regains its former health, and the whole course of the disease may be so mild that the patient cannot be persuaded to remain in bed.

Complications.—The most common are affections of the *respiratory tract* (pneumonia or severe bronchitis), and in some cases we have a *gastro-intestinal catarrh* of a troublesome character. *Diphtheria* or other contagious diseases may occur. A *relapse* is not uncommon, and may be as severe as the initial attack.

Diagnosis.—Rubella may be distinguished from *measles* by its less severe onset and course, by the absence of coryza, severe bronchitis, high fever, Koplik's spots and complications, by the lighter color, shorter duration, and more diffuse character of its rash, and the irregular shape which the patches assume. The presence or absence of an epidemic is an important factor in the diagnosis, and in cases occurring when there is no epidemic the diagnosis between this disease and measles of a mild type is difficult if not altogether impossible.

From typical *scarlatina* the diagnosis offers no difficulty. The absence of its initial vomiting, the strawberry tongue, the character of the rash (which in scarlet fever is erythematous), and the shorter duration and milder course of rubella, all render the diagnosis easy. Furthermore, a polynuclear leukocytosis suggests scarlet fever; a lymphocytosis, rubella.

RUBELLA.	ERYTHEMA	URTICARIA
Occurs first on the face.	On the hands and feet.	In wheals on arms and legs.
Enlargement of cervical glands.	No enlargement.	No enlargement.
At first no itching.	Burning pain.	Intense itching.
Contagious.	Not contagious.	Not contagious.
Microbic origin.	Vascular in origin.	Anaphylaxis.

The **prognosis** in uncomplicated cases is invariably good, but when the surroundings are unhygienic, or in cases in which the child has been delicate previously, it is more serious. Complications, especially pneumonia or diphtheria, may prove fatal, and in some cases the mortality reported has been as high as 9 per cent.

The **treatment** is simple and principally symptomatic. A mild cough-mixture, such as is recommended in measles for the bronchitis, nutritious but easily digested food, and medicine to regulate the bowels when necessary, fulfil all the indications for internal medication. As in measles, cool sponging should be resorted to before and during the rash; and, when the fever is high, a cool tub-bath, where practicable, will be found to reduce the temperature, quiet the patient, and hasten the appearance of the eruption. During convalescence, if the child does not rapidly regain his appetite and strength, tonics, such as tincture of nux vomica and syrup of hydriodic acid, are indicated. The child should be isolated for seven days from the appearance of the rash.

The complications are to be treated as they arise, but the sponging should not be discontinued until the temperature becomes normal.

WHOOPING-COUGH

(*Pertussis; Tussis Convulsiva; Keuchhusten*)

Definition.—Whooping-cough is a highly contagious disease, characterized by a catarrhal inflammation of the respiratory tract, associated with a peculiar spasmodic cough, ending in a whooping inspiration.

Pathology.—There is no lesion that can be considered characteristic of whooping-cough, and none around which all the symptoms and complicating conditions are grouped. In the beginning there is catarrh of the nasopharynx, and this may be the only change coincident with the development of the characteristic cough. Mallory found the causative organisms packed between the cilia of the epithelial cells of the trachea. The bacilli, by interfering with the normal movement of the cilia, provoke a constant irritation which excites coughing. In advancing cases this nasopharyngeal catarrh becomes generalized by extension to the lacrimal ducts, the conjunctivæ, the eustachian tube and the middle ear, to the glottis, trachea, large and small bronchi, and the air-vesicles. The more decided pulmonary lesions—emphysema, pulmonary collapse, pulmonary congestion and edema, and bronchopneumonia—are advanced pathologic conditions accompanying the later stages (W. W. Johnston).

The *postmortem* table does not give much information as to the pathology except as to the sequences of the disease. In the early stages swelling and redness of the respiratory and digestive tracts will be found, together with a large quantity of viscid mucus.

Etiology.—The disease occurs in *epidemics*, yet occasionally may appear *sporadically*. Pertussis seems to have a tendency to occur in epidemics every two years, although in large cities the disease is generally endemic. Pertussis is directly *contagious*, though scarcely so in houses and school-rooms, unless it be for those of a specially susceptible nature. It is possible, however, for the disease to be propagated in schools, though not to the same extent as measles and scarlet fever. It seems that a more decided and prolonged personal contact must be made, as with members of a family, to ensure transmission. One close exposure in a susceptible child may be sufficient to ensure an attack.

PREDISPOSING CAUSES.—The influence of the *seasons* does not seem to have any effect, though perhaps fall and spring are the more frequent periods; the station in life, whether hygienic or unhygienic, does not modify the disease. *Bad ventilation*, however, may propagate the disorder, and cause additional cases by favoring the increase of germs in the immediate surroundings. The *previous condition of health*, especially of the respiratory mucous membrane, seems to possess some predisposing influence, weak, delicate children, with an irritable digestive tube associated with a catarrhal state of the respiratory passages, more readily contracting whooping-cough than those in robust health.

There is an intimate association between whooping-cough and *measles*; epidemics of measles are often followed by whooping-cough in the same sufferers. This is possibly due to the sensitive condition of the mucous membrane left by the measles, which is so favorable to the lodgment of the germs of pertussis; and the association of the two diseases must be more than accidental. There exists a certain individual susceptibility, which, however, is not universal to whooping-cough, as well as to other infectious diseases.

Age exercises some influence on the development of whooping-cough, most cases occurring before the tenth year; after this time the frequency of the disease rapidly diminishes. West states that one-half of all cases develop

under three years, but he must have based his knowledge upon an experience in hospitals and children's homes, as the experience of others does not sustain his statement. The disease occurs in adults but rarely, this being due partly to the fact that so many have suffered from it while young, and partly to a lessened susceptibility. It occurs frequently before the first year, and when it does it is the most fatal of all the diseases of childhood (Goodhart).

The *sexes* are about equally divided as regards susceptibility; many writers, however, seem to think that girls are more liable.

The *highway* of the contagion of whooping-cough into the system is the respiratory tract. Published cases of pertussis in the newborn would even seem to make its transmission possible through the fetal circulation, yet the reports are neither numerous nor satisfactory. One attack is usually protective for the rest of life, although exceptions to the rule may be found.

Bacteriology.—The researches of Mallory have shown conclusively that whooping-cough is caused by the Bordet-Gengou bacillus—*Bacillus pertussis*. This organism is a short, plump, non-motile, Gram-negative bacillus. It enters the body through the external air-passages and lives chiefly between the cilia of the epithelium lining the trachea and bronchi. It is found most abundantly in the sputum during the catarrhal stage and the first week of the spasmodic stage, but has been found in the sputum expectorated in the eighth week of the last stage. It may be appreciated, therefore, that the disease is much more contagious in the early than the late stages of the disorder. Moreover, the bacillus is readily destroyed outside the body so indirect contagion is probably of but minor importance. In some uncomplicated cases a bacteriologic diagnosis is possible by staining smears of the sputum coughed up from the trachea. An agglutination reaction may be obtained, but the results are rather uncertain, though, of course, a positive reaction is positive proof of the existence of the disease. Complement-fixation tests are also obtainable, but not until the latter stage of the disease, when a diagnosis upon clinical findings can be made without question. The reaction may persist for months after subsidence of all clinical symptoms. Some writers (*e. g.*, Friedländer) by a special technic claim to get 100 per cent. of positive reactions in even the earliest stages. The action of the bacillus is believed by Mallory to be largely mechanical, though it produces a mild toxin.

Clinical History.—The period of incubation varies from four to fourteen days, according to the extent of catarrhal trouble in the child existing at the time. Goodhart gives several authenticated cases in which the incubation ended on the eighth day. In the beginning the symptoms are those of a slight bronchial cough, which has a tendency to be more pronounced during the night. After a few days the cough assumes an influenzal character, and at the same time it gradually grows metallic in ring and shows a laryngeal type. There is some fever present. There is a pronounced leukocytosis, with preponderance of the lymphocytes. This **catarrhal** or **feverish** stage lasts for a week or more, when it is followed by the **paroxysmal stage**, and these stages are divisions of the symptoms worthy of recognition, as the treatment in the first is not applicable to the second. Many authorities speak of a third stage as one of **decline**, which does not sharply occur, but includes the sequence of the disease. The **catarrhal stage** lasts about one week or ten days, during which the child is ill at ease, is feverish, and has a hoarse, dry cough. The symptoms may either be entirely laryngeal at first or bronchial, with a loss of appetite and broken rest at night. Auscultation at this time will reveal a few moist or dry râles in the larger bronchial tubes, but there is very little secretion. The cough seems to be out of proportion to the physical

gns. As the catarrhal stage proceeds the cough commences to indicate its character by becoming more noisy, increasing especially at night. The physiognomy of the child commences to change, the face is swollen, the eyes suffused and watery, the under lids swollen and pink in color. This is one of the most decisive indications of the trouble, and may be recognized by a careful observer a few days before the "whoop" begins which stamps the disease and ushers in the second stage. The commencement of the **paroxysmal stage** is quite different from the easy and more constant coughing of the first stage. If the child is in bed, the onset of a paroxysm is usually quite sudden, but if he is up and playing, there is a period of restlessness, a premonition of the coming storm similar to the aura in epilepsy, and the child may even have time to run to his mother or nurse before the paroxysm comes on. Usually the paroxysms are induced by a quick inspiration, as during drinking, eating, or crying. The first (expiratory) part is short, and followed by a short whoop; this is very quickly followed by a long series of short expiratory efforts and a second and longer whoop, when the paroxysm may cease. In some cases a third and a fourth may quickly follow, until the child is quite exhausted. The paroxysms, whether short or long, generally terminate with vomiting or eructation of a quantity of stringy mucus. Food is ejected, and in most cases a little blood is mixed with the vomited mucus.

At this stage of the disease, if at all severe, the *countenance* of the child is characteristic, and so much so that a mistake is no longer possible: the features are swollen, puffy, and dusky in color; the eyes are injected, the lids swollen and pink; the skin livid, due to a minute ecchymosis of the smaller capillaries. In many cases there will be extravasation of blood beneath the conjunctiva, due to the violence of the congestive cough. If the chest be examined at this stage, it will tell but little, provided we have no bronchopneumonia, though a few moist râles may be found scattered through the larger tubes. The blood shows leukocytosis, especially when there are bronchitic complications. Benstz found the number of eosinophils to be below normal in all of 63 cases, while the mononuclear and transitional forms were much increased, reaching 18 per cent. at the height of the disease. Other observers have claimed to find a fairly well-marked eosinophilia persisting for some time after the disappearance of the paroxysmal stage. The most characteristic blood finding, however, and one that is present in all uncomplicated cases, is a lymphocytosis. A relative and frequently an absolute increase in the number of lymphocytes which varies between 40 and 60 per cent. thus becomes an important diagnostic aid.

The spasmodic stage of whooping-cough has no set *duration* and varies frequently in intensity. In severe cases it may consist of twenty to forty paroxysms during the twenty-four hours. Some spasmodic coughs are not accompanied by a whoop, and the absence of this sign may be noted in very young children, as well as in those that are very ill with bronchopneumonia. Some children vomit after a coughing spell without the whoop.

It is frequently observed that long after the spasmodic spell has come to an end the paroxysms return again and again, perhaps years afterward, with almost characteristic features, evidently acting under the stimulus of some perfectly neutral catarrh.

Complications.—In severe cases the complications may be numerous.

Epistaxis often occurs in children; *hemoptysis* when vomiting is frequent; *ulceration* of the frenum linguæ in violent coughing; *convulsions* in vigorous children; and *bronchopneumonia*, *pleurisy*, *pericarditis*, *laryngitis*, and *hernia* in severe, prolonged coughing. Convulsions and bronchopneumonia are alarming, and in young children a *profound stupor* may replace the convul-

sions. Eshner states that peripheral neuritis is a rare complication of this disease. Interlobular emphysema has resulted from whooping-cough (Finch).

Sequelæ.—*Acute nephritis* frequently occurs, and is as severe as that found in scarlet fever. In a series of over 200 cases I have found the kidneys affected in 20 per cent. Knight found albuminuria in 66 out of 86 cases examined. *Emaciation* is a very important sequence of pertussis. All the viscera are liable to fatty degeneration, and nutritional changes open the door to cheesy, glandular alterations, and eventually to a secondary tuberculosis. Atelectasis, by curtailing lung space, frequently brings about a general collapse, and this condition frequently explains the flattened chest found in young adults. Conversely, emphysema may be initiated by pertussis early in life. Emaciation may also be due to *mucous disease*, a chronic gastro-intestinal catarrh of long standing.

Prognosis.—Associated with its complications, pertussis is a very fatal disease, especially in children under two years of age. Veeder says, "About 80 per cent. of the pertussis deaths are in infants under two years, and 99 per cent. in children under ten." Dolan regards it as third in rank among the fatal diseases of England, where the death-rate per 1,000,000 is 5000 annually. The deaths occur chiefly among children of the poor and in bottle-fed infants.

Goodhart regards whooping-cough as the most fatal of all the diseases in children under one year of age. He places the mortality at 12 per cent., and thinks that this is not too high; his statement, however, is hardly warranted, as he includes the deaths from the many sequelæ which we cannot estimate. Ashby and Wright place the mortality at 7.6 per cent.

Differential Diagnosis.—Young infants usually do not "whoop," but cough spasmodically. The complement-deviation test is of the greatest possible value for diagnosis at all stages (Friedländer and Wagner²), while the agglutination reaction, when positive, is definite evidence as to the presence of the disease, though occurring late in the course. They may be employed as a means of differentiating the various affections likely to be confused with pertussis (*vide infra*). The lymphocytosis is also a valuable differential aid. Chievitz and Meyer claim that an early diagnosis can be made by cultural methods. The mucopurulent flocculi from the last portion of the sputum is washed in salt solution and then rubbed over the medium (blood-potato-agar). The colonies appear in about four days as minute glistening drops. The agglutination of these colonies is then attempted with serum from an animal immunized with *Bacillus pertussis*. Agglutination of the bacilli takes place if they are the specific organism.

Children with *pleurisy* or *pneumonia* do not whoop, yet we diagnose whooping-cough by the preceding catarrhal fever. From *influenza* in its early stages it is most difficult to differentiate the affection. The pink under eyelid has to me been the most certain sign. When the whoop appears and during the existence of an epidemic, however, the diagnosis may be rendered certain.

The diagnostic points prior to the whooping stage enunciated by Eustace Smith are as follows: "If a child be made to bend back the head, so that his face becomes almost horizontal, and the eyes look straight upward at the ceiling above, a venous hum, varying in intensity according to the size and position of the diseased glands, is heard with the stethoscope placed upon the upper bone of the sternum. As the chin is now slowly depressed the hum becomes less loudly audible, and ceases shortly before the head reaches its ordinary position." It is true that we do not recognize the hum caused by the enlarged bronchial gland, but it occurs long after other symptoms are manifest.

¹ *Amer. Jour. Dis. of Child.*, August, 1914.

I have for several years been able to place considerable value on the peculiar fulness of the mucous membrane of the eyes and the swollen or edematous condition of the whole face and almost dusky color. This condition may exist a few days before the catarrhal symptoms have extended throughout the respiratory mucous membrane. The cough at this stage may not be at all suggestive, but purely bronchial.

This symptom of fulness about the eyes suggests *measles*, and must be differentiated from it. As we are able to diagnosticate measles by its appearance first on the hard palate, so we may diagnosticate whooping-cough in its earliest stage by the characteristic swollen condition of the eyes and face. The diagnosis may be confirmed by lymphocytic leukocytosis and the presence of a sublingual ulcer.

Treatment.—The gravity of pertussis is scarcely appreciated either by the general physician or the public. Although extremely contagious during the primary catarrhal stage, quarantine should be rigorously observed until the end of the fourth week.

Hygiene.—Throughout the whole course of the disease outdoor life, as far as possible, should be encouraged, and if convenient a sojourn at the seashore will shorten the progress of the trouble and limit to a great extent the number of sequelæ. Only the severe and complicated cases need to be kept in bed. It has been shown that the number of attacks is directly dependent upon the amount of CO₂ present in the atmosphere (Forcheimer). In cities the sufferer must be protected against the dust; this may be accomplished by the wearing of a veil in suitable cases.

Medicinal treatment is exceedingly unsatisfactory, although the therapeutic measures which have been advocated are boundless. The remedies most in use are the antispasmodics and the germicides, though recently specific therapy, in the form of vaccines of killed bacteria, has held out much hope as a therapeutic measure.

Whooping-cough has a striking parallel in diphtheria, in that it has in its early stages a strong tendency to fasten itself upon the throat. How long this period exists we do not know to a certainty; yet there is undoubtedly a period in whooping-cough, as there is in diphtheria, long or short, in which the germ could be destroyed and the disease terminated. To abort cases thus within two weeks is not unusual, and this explains the number of reported cures made by germicidal remedies.

In my treatment of this disease I find the greatest necessity for recognizing the affection early in the catarrhal stage. We must remember that the two stages are not sharply defined, and that either the one or the other may be lacking. The drugs I have found most efficient in the catarrhal stage have been hydrogen peroxid for sterilizing the nasopharynx, and belladonna and *asafoetida* for the paroxysms.

To be more explicit, I will detail the methods of procedure in a family in which I have instituted my plan of thorough treatment: A child of four years attending kindergarten was brought to me with a suspicious cough. The history was given of an exposure of over two weeks prior. The child had coughed for a few days, more at night than in the daytime; was feverish during the evenings; showed slightly swollen eyelids, thus suggesting the nature of the impending trouble. I ordered hydrogen peroxid and pure glycerin in equal parts, which were well diluted and thoroughly sprayed through the nasopharynx every four hours. The diet was light and digestible; outdoor life was encouraged except on windy days. At night the child was placed in a large, well-ventilated room, and over its cot was erected a mosquito netting so as to prevent any unusual draft—a procedure which I have found highly

beneficial. When the cough was fully established and was accompanied by eructations of stringy mucus I commenced the exhibition of the mixture of asafetida $\frac{1}{2}$ dram (2.0) every two hours. The record of the paroxysmal stage was as follows: The first week averaged six coughing spells per day; the second week averaged ten per day; the third week, four paroxysms; and the fourth and fifth weeks averaged about two paroxysms during the twenty-four hours. When the younger brother, but eight weeks old, commenced to show evidences of the disease I first used hydrogen peroxid as in the older brother, and immediately followed it with asafetida. The case ended favorably.

My second choice is the tincture of belladonna, exhibited in doses of 1 drop for every year of the child's life, the doses being increased until toxic effects are reached. Then I gradually increase the amount as tolerance of the drug seems to be established. In very young children I have obtained good results from the use of a freshly prepared belladonna plaster placed between the scapulæ, and the physiologic action of the drug seems thus to be more constantly maintained. I have gained a decided advantage by an application of a 2 per cent. cocain solution to the nasopharynx in bad cases. Irrigation of the nostrils thrice daily with a 1 : 40 carbolic acid solution has proved curative in its effects. Bradt declares that local treatment of the nasopharynx tends to arrest the syndrome.

Bromoform was resorted to in fully 20 per cent. of my cases, and was a keen disappointment. The coal-tar products, pushed to the toxic limit, modified the disease but slightly. A drug that has almost reached the rank of a specific in my hands is the following: Atropin sulph., gr. j; aqua destil., ʒj . Each drop contains $\frac{1}{160}$ gr. atropin, and this dose may be increased drop by drop until the full physiologic effect of the drug has been obtained. If this effect is maintained with the onset of the paroxysmal stage much time is saved. This outline of the drug treatment in whooping-cough has reference solely to the catarrhal and paroxysmal stages of the disease. Kilmer has advocated a tightly placed thoracic and abdominal belt, which has yielded great satisfaction. Goodson commends the use at the earliest moment of the continuous inhalation of creasote; he also advocates clearing the lungs of bronchitis as much as possible before using any special internal antispasmodic remedies.

Specific Therapy.—Prophylaxis.—Hess employed prophylactic vaccination upon the outbreak of whooping-cough in an institution for children. He concluded that the vaccine materially lessened the number of cases. Goler¹ states that out of 10,000 children vaccinated against whooping-cough in Rochester, less than 5 per cent. came down with the disease. Prophylactic doses are 500,000,000, 2,000,000,000, and 3,000,000,000 bacteria given every third day.

Treatment.—The results of vaccine treatment, as detailed by Park, are distinctly beneficial on the whole, though Hess in his article does not so conclude. Luttinger holds that stock vaccines, tried in 138 cases, shortened the paroxysmal stage by almost two weeks. Dr. Park recommends a dose of 500,000,000 killed bacteria to a child over one year of age, 1,000,000,000 to an adult, and 250,000,000 to a child under one year. This initial dose is doubled two days later, and again this second dose is doubled and given forty-eight hours afterward. If no improvement is shown, still further injections may be given.

Complications and Sequelæ.—Complications may be avoided by maintaining constantly the alkalinity of the body fluids. Sodium bicarbonate and the various alkaline waters are strongly indicated, and milk should be given in seltzer water.

Diet of the simplest character and a uniformly quiet life must be maintained.

¹ *New York State Jour. Med.*, September, 1917, p. 411.

MUMPS

(Parotiditis; Epidemic Parotitis)

Definition.—An acute contagious disease characterized by an inflammation and swelling of the parotid gland, and occasionally by an involvement of the salivary glands, the testicles, and in the female, the mammæ.

Pathology.—Opportunities for postmortem examinations are rare, leaving in some doubt the pathologic course of the disease; but it probably begins as a catarrhal inflammation of the ducts, involving the periglandular connective tissue. The inflammation is seldom severe enough or of such a nature as to produce suppuration.

Etiology.—Mumps is undoubtedly a constitutional or blood disease with local manifestations. "It is a question," Goodhart says, "with mumps whether this disease shall be placed with the specific diseases or with those affecting the parts or organs with which the symptoms more particularly concern themselves."

The disease is no doubt of *microbic origin*, but the specific organism has not yet been isolated. Dr. Martha Wollstein, at the Rockefeller Institute for Medical Research, has succeeded in reproducing the lesions of parotitis in animals by means of filtered extracts of saliva derived from persons suffering from mumps. In a more recent article¹ she confirms these findings and notes that the virus of parotitis was found most readily in the saliva in the first three days of the disease, and not at all by the ninth day. She found it also in the blood of patients with severe constitutional symptoms. Haden,² however, reports 4 cases of mumps in which a Gram-positive diplococcus was isolated from the spinal fluid, the blood, and a lymph-gland, and when injected into the testicle of a rabbit this organism produced a severe orchitis.

Mumps is highly *contagious*, and at times, usually during the spring and autumn, becomes epidemic. It is communicated principally by the *breath* and *exhalations*, the greatest source of contagion being the salivary secretions. It may, however, be carried by a third person or by fomites, and is most liable to be communicated during the beginning of the attack, although the contagiousness continues until after the subsidence of the febrile symptoms. It occurs mostly among *children* and *young adults*, infants and old persons being rarely affected, while males are more liable than females. One attack usually gives *immunity* from a second attack in the same gland.

Clinical History.—The average period of *incubation* is fourteen days, but it may develop as early as ten or as late as twenty days after exposure. A most valuable pathognomonic sign, observed in the prodromal stage before any other symptom or sign appears, and which may be likened to Koplik's sign in measles, has been noted by Hathcock. It consists of tenderness just beyond the angle of the jaw severe enough to make the patient wince when the finger is run toward the angle under the mandible. The *invasion* is marked by languor and a temperature from 101° to 103° F. (38.3°–39.4° C.), with possible headache and vomiting; the patient complains of pain at the angle of the jaw, and this is greatly increased if an acid (such as vinegar) is swallowed. With these symptoms is noticed a *pyriform swelling* of the parotid glands, the one on the left side usually appearing first, and the other one soon following. Occasionally cases are seen in which but one gland is involved, or the swelling may begin in both at the same time. This increases gradually until some time between the third and sixth days, involving the other salivary glands and causing marked disfigurement; the swelling fills the depression beneath the ear and extends to the cheek and neck, the most prominent part

¹ *Jour. Exper. Med.*, 1918, xxviii, 377.

² *Amer. Jour. Med. Sci.*, 1919, clviii, 698.

being just below, and pressing outward, the lobe of the ear. The *salivary secretions* are generally much increased, though there may be the opposite condition of marked dryness of the mouth. When the swelling has reached its height, pressure on the adjacent tissues causes a disagreeable sensation of tension, and chewing, swallowing, and even speaking are at times painful and difficult. The *skin* over the affected part may be of a pale or of a dull-red color. Ringing in the ears and a dulling of the hearing is common. The *nervous system* may be affected, causing headache and delirium, or a low typhoid state may be present. As to the *blood*, Feiling¹ claims that there is a slight increase in the total number of leukocytes, with a relative and absolute lymphocytosis. Radin² reports no change in the total leukocyte count, but with a relative lymphocytosis. In cases associated with complications (orchitis) there is a total increase and a slight relative increase in the polynuclears. Capitan emphasizes early hypertrophy of the spleen as an aid in differential diagnosis. The *duration* is about one week (six to ten days), after which time the swelling subsides, and by the tenth or twelfth day entirely disappears.

The **diagnosis** is easy, the nature and position of the swelling and the course of the disease being characteristic, while the fact that the tonsils are seldom involved prevents a diagnosis of acute tonsillitis.

Occasionally, however, in the course of *septic infection* or after operations, or owing to the extension of inflammation along the duct from the mouth, the parotid gland becomes the seat of an acute inflammation at first hardly distinguishable from mumps. The existence of a possible source of infection, and the fact that the gland under these circumstances usually undergoes suppuration, should lead to the recognition of the true nature of the case.

Complications and Sequelæ.—Mumps, as a rule, runs a mild course without any serious symptoms, but occasionally complications arise. The most common of these are *orchitis* in the male, which may be followed by atrophy of the testicle; and *mastitis*, *ovaritis*, or *vulvovaginitis* in the female, especially after puberty. The complications appear after the subsidence of the swelling of the glands of the neck, only occasionally developing while the glands are still affected, though cases have been reported in which the disease first manifested itself by involvement of the sexual organs. This complication lengthens the course of the attack and increases the constitutional symptoms, but the rule is complete recovery. *Otitis media* sometimes occurs, and a lesion in the auditory nerve, with more or less deafness (which, unfortunately, may be permanent), has been observed. *Facial paralysis*, *convulsions*, *albuminuria*, and *arthritis* have all been noted in certain cases. Haden³ reports cerebral complications occurring in 9 of 476 cases of mumps. This was an encephalitis, not a meningitis, and was usually promptly relieved by lumbar puncture. Tasker Howard⁴ reports 3 cases of meningo-encephalitis as the only manifestation of mumps. Pujol met with 9 cases of myocarditis among 450 soldiers with mumps. Jacob and others report cases of mumps complicated with acute pancreatitis. Four such cases were seen by Radin⁵ during the course of an epidemic at Camp Wheeler, in which over 5000 cases were observed and studied by him. Radin also writes that in this same epidemic orchitis and epididymitis occurred in 611 cases.

Treatment.—The patient should be kept in a well-ventilated room of even temperature, and in bed if the fever is at all severe, and should be isolated from those who have not had the disease. Hess gave protective

¹ *The Lancet*, London, July 12, 1913.

² *Arch. Int. Med.*, 1918, xxii, 354.

³ *Ibid.*, 1919, xxiii, 737.

⁴ *Amer. Jour. Med. Sci.*, 1919, clviii, 685.

⁵ *Arch. Int. Med.*, 1918, xxii, 354.

njections, using whole blood from donors either just, or about ten days previously, recovered from mumps, with striking results and without any disagreeable manifestations. Either hot or cold applications to the swelling will often give relief, and support to the swollen gland by means of cotton and a bandage is very comforting. Saline laxatives may be given, and aconite or some simple fever mixture at the beginning of the attack is usually indicated. These simple measures are all that are required in an ordinary case, while complications or unusual conditions must be treated as they arise. Isolation should be continued for one week following the disappearance of the swelling.

TUBERCULOSIS

Definition.—A chronic (less frequently acute) infectious disease caused by the *Bacillus tuberculosis*. This organism produces specific lesions, taking the form either of separate nodular masses or diffuse growths, infiltrating the tissues, while aggregations of these elementary tubercles give rise to large tuberculous masses. Tubercles undergo caseation and sclerosis, followed in turn by ulceration (in consequence of secondary pyogenic infection), or, more rarely, calcification.

Historic Note.—Prior to the discovery in the early part of the nineteenth century by Bayle and Laennec of the tuberculous new growth as a distinctive body, this disease had been studied chiefly from a clinical point of view. At this early period the disease was believed to consist chiefly of a suppurative process, and in its observation the physician was unaided by auscultation. Later the tubercle was recognized as a small rounded nodule without any special histological characteristics. Villemin in 1865 performed his epoch-making experiments, and the tubercle was no longer distinguished by its anatomic characters alone. Though the theory of the infectious nature of tuberculosis had been previously advanced by Buehl and others, it was first clearly demonstrated by Villemin's beautiful inoculation experiments upon rabbits and guinea-pigs with particles of tubercular and cheesy substances, producing the characteristic lesions of tuberculosis. It then remained for Koch to discover (in 1881) the specific cause of the most important of all human ills—the tubercle bacillus. So soon as the specificity of the disease was definitely established it became clear that the associated inflammatory processes, that were formerly believed to be primary lesions, were secondary.

Geographic Distribution.—Tuberculosis prevails in almost every quarter of the globe, but is more prevalent in certain latitudes than in others. Thus, in general terms, it may be said to prevail more extensively in warm than in cold countries. Local conditions, however, exercise a more decisive influence in engendering predisposition than mere geographic position. It is of quite frequent occurrence in all densely populated municipalities, and more especially in the overcrowded sections of the latter; this fact explains why the inhabitants of cities of the North are but little less spared than those of the cities of the South. On the other hand, residents of mountainous countries, owing to the purity of the atmosphere and the elevation, are rarely victims.

General Pathology of Tuberculous Lesions.—**Distribution of the Lesions in the Body.**—Tuberculous new growths elect most frequently the lung, and when the disease occurs in the adult this organ is almost invariably implicated. Next in frequency follow the larynx, intestines, peritoneum, urogenital organs, and the brain. The other chief viscera of the body (spleen, liver, heart, etc., particularly the latter) are less commonly the seat of tuberculosis. In children the lesions exhibit a different distribution, the favorite seats being the lymph-glands, intestines, bones, and joints. In them the dis-

tribution corresponds pretty closely, if we except the bronchial and mesenteric glands, to that of surgical tuberculosis.

The Elementary Tubercle.—This may be developed in any tissue to which the tubercle bacillus has found its way, and the presence of the bacillus is its sole distinguishing feature, since apparently identical bodies are produced by other micro-organisms.

The various stages in the development of a tubercle are—

(a) *Proliferation* of the fixed tissue elements (connective tissue, endothelium of the capillaries, etc.) of the part infected, due to the local, specific irritant action of the bacilli. These anatomic elements are transformed into epithelioid and giant cells. The epithelioid cells assume various shapes, chiefly rounded and polygonal; they have vesicular nuclei, and soon show tubercle bacilli in their interiors. A certain proportion of the epithelioid cells, as the result of increase in their size and a repeated division of their nuclei, or by union of contiguous cells, become *giant cells*. The latter occupy the center of the tubercle and also contain bacilli, the number of giant cells and of the bacilli being largely reciprocal. Thus, the giant cells are numerous in tuberculous lymph-glands, joints, etc., in which the bacilli are relatively few; on the other hand, they are scanty in miliary tubercles in which the bacilli are numerous—two facts supporting the view that giant cells display phagocytic action. Hektoen asserts that the giant cell is a living defensive agent.

(b) About the site of infection a *diapedesis of leukocytes* occurs in the nature of a defensive inflammatory process. At first the leukocytes are of the polynuclear variety and are quickly destroyed; but later mononuclear leukocytes (lymphocytes) appear. These latter resist the action of the bacilli, and I think their true function is a phagocytic one. The various forms of cells described are connected and surrounded by a reticular stroma “formed by the fibrillation and rarefaction of the connective-tissue matrix” (Baumgarten).

The **fully developed tubercles** are small nodular bodies whose diameters range from $\frac{1}{2}$ to 2 or 3 mm. At first they are almost transparent, but soon lose this quality in consequence of the further changes described below. They are avascular bodies, and invariably undergo degenerative changes—(a) *caseation* and (b) *sclerosis*.

(a) *Caseation*.—This implies “coagulation necrosis”—a destructive process proceeding from the center toward the periphery of the tubercle, and the result of the local action of the bacilli or their toxins. The cells are thus transformed into a uniformly yellowish-gray structureless matter. When the foci are numerous and closely set, fusion may occur, with the production of larger or smaller homogeneous masses (cheesy pneumonia). The latter may soften, resulting in the formation of cavities; this is due usually to secondary pyogenic infection, causing ulceration. Less frequently the cheesy masses undergo calcification or become encapsulated, and are then practically harmless.

(b) *Sclerosis*.—Preceding and during the time that cell destruction is going on in the center of the tubercles the protective forces of nature are asserting themselves, though too often without avail. In the first place, hyaline transformation with conversion of the cellular elements into fibrous connective tissue occurs. Frequently now the center of the tubercle is caseous and contains bacilli, while the peripheral parts are quite hard. Here the bacilli are incarcerated (*latent tuberculosis*). The fibroid change may pervade the entire tubercle. Again, the fibroid element in the tissues immediately surrounding the tubercle may be greatly increased and form new connective tissue, and this process be followed by secondary contraction, converting the tubercle into a firm fibrous nodule. The fibroid change in its completest development is observed in tuberculosis of serous membranes.

Limitation of the tuberculous process takes place by fibrous encapsulation.

Naegeli and others have shown that practically all adults have somewhere in their economy healed tuberculous lesions. However, the bacilli may fall upon a receptive, favorable soil, and extension occurs by the appearance of secondary tubercles in adjacent tissues. The dissemination and transportation of the bacilli are effected principally through the lymph-channels and blood-vessels. Again, infection may occur by actual contact of the affected organ with neighboring parts, the disease spreading by continuity. Lastly, lesions may be propagated by the movement of organs; thus localized peritoneal tuberculosis may rarely become generalized in consequence of the peristaltic movements.

Again, fusion of minute centers of infection or of miliary tubercles results in the formation of larger nodules or areas, which lead by a process of local extension to *diffuse tuberculous infiltration* (gray infiltration of Laennec). An entire lobe may become similarly involved (tuberculous pneumonia), and "there may also be a diffuse infiltration and caseation without any special foci, a wide-spread tuberculous pneumonia induced by the bacilli" (Osler).

The term "gray infiltration" is misleading, since the morbid changes differ in no essential manner from those described as occurring in the miliary tubercle. Moreover, the latter also presents a grayish appearance. The apparent difference between a miliary tubercle and diffuse tuberculous infiltration lies in the fact that the latter displays a clearer tendency to spread by direct extension.

Associated Inflammatory Processes.—The tubercle bacilli excite associated inflammatory processes in the organs affected, and if the tuberculous lesions run a slow course a limiting wall of true fibroid induration circumscribes the area involved. By means of this induration the natural protective forces, either temporarily or permanently, check the progress of the local lesions, and the change is strictly analogous to the sclerosis that takes place in the peripheral parts of the elementary tubercle or immediately surrounding the latter, as in tuberculosis of serous membranes. On the other hand, when the tuberculous infiltration is less tardily developed the collateral reactive inflammation may show changes similar to those of catarrhal or croupous pneumonia (*vide supra*). Examination of the sputum to determine the nature of a mixed infection is of little value, since the sputum may show various organisms that have not caused any real infection, and that have entered the sputum from the throat or buccal cavity.

Etiology. — THE SPECIFIC

CAUSE AND ITS PHYSICAL CHARAC-

TERISTICS.—In 1881 Koch dis-

covered the tubercle bacillus

which is the sole cause of the dis-

ease. The bacillus is rod shaped,

straight or somewhat bent, and

slender, its length equaling about

one-third or one-half of the diam-

eter of a red blood-corpuscle

(Fig. 19). Its ends are slightly

rounded, it is non-motile, and on

the interior of the bacillus small

colorless spots can be observed on

microscopic examination; these

clear spaces represent plasmolysis.

Spores do not occur except in mixed

infection (e. g., old cavities) due to symbiotic growth.

When stained the bacilli have a somewhat beaded appearance. The



Fig. 19.—Tubercle bacillus in sputum (Fränkel and Pfeiffer).

tuberculous processes is intimately connected with the degree of resistance offered by the tissues. A chronic tuberculous focus may establish a fistulous connection with a vein or a lymph-vessel, and thus scatter the bacilli to the remotest parts of the body; and in such instances (as the direct effect of the original number of bacilli present) a chronic is quickly converted into an acute form of tuberculosis. In chronic tuberculosis, tubercle bacilli in the circulating blood, "at least in sufficient number to infect a guinea-pig, are relatively infrequent" (Clough). Strauss demonstrated virulent bacilli within the nasal cavities of healthy persons whose positions necessitated their association with, and frequent presence in rooms occupied by, tuberculous patients.

(b) *The Bacilli Outside of the Body.*—Tubercle bacilli can maintain their existence almost indefinitely outside the body. On the other hand, they probably do not develop or multiply under the usual external influences, but their vitality is extraordinary. Their destruction cannot be effected by freezing or by desiccation, and they survive for months in water. Their power to resist chemical agents (nitric acid, etc.) is also very great, but they may be destroyed by boiling for four or five minutes or by exposure to the direct solar rays from four to eight hours (Jousset). In milk they may be destroyed by heating in a closed pasteurizer for a period of twenty minutes at 140° F. (60° C.). Tubercle bacilli are undoubtedly present in all inhabited places, and they may be conveyed for long distances by means of water, food, and fomites. Willson and Rosenberger have shown that the presence of living tubercle bacilli in the urine and the feces is of importance in relation to the infectiveness of sewage and of drinking-water.

The *sputum* dries and flies into the atmosphere in the form of dust, which not only floats in this medium, but also settles upon articles of furniture, the floor, the walls of living-rooms, hospital wards, draperies, clothing, bed-linen, food-stuffs, etc., and from these resting places it may be conveyed back into the atmosphere. It has been shown experimentally that the dust obtained from the walls or from the air of rooms and hospital wards occupied by tuberculous patients is frequently, though not invariably, infected. It is the *indoor atmosphere*, laden with bacilli, that is especially liable to be dangerous. In places only rarely frequented by consumptives the dust is usually free from virulent bacilli.

MODES OF INFECTION.—(1) **Inhalation of the Bacilli.**—Inhalation tuberculosis is, doubtless, less common than formerly supposed, but it still remains the greatest and most frequent mode of infection. It is the route followed in the majority of cases according to Ravenel. Klebs and Flügge claim that infection may result from moist particles (salivary droplets) thrown off in coughing, and Boston has demonstrated that in 75 per cent. of consumptives, with cavity formation, a fine spray containing tubercle bacilli is emitted during the acts of coughing, sneezing, laughing, and talking. Ravenel has shown experimentally that tubercle bacilli may be disseminated by cows in coughing. It is highly probable that such spray magnifies the danger of infection from tuberculous cooks and bakers. Occasionally the bacilli attack first the upper respiratory passages (larynx, nose) or, as in the case of cervical tuberculous adenitis, they enter through the tonsils. Usually, however, primary infection takes place in the *smaller bronchi* in the apical area or, less frequently, in a *bronchus*; this is shown by the fact that healed lesions in persons dying of other causes are commonly met with in these situations. The *bronchial lands* may be found to present tuberculous lesions.

Man possesses a high degree of resistance to the tubercle bacillus, and for this reason tuberculosis is not contagious in the sense that scarlet fever, small-pox, and similar diseases, for which the organism has but little natural resistance,

are contagious. It is a question of repeated and prolonged exposure rather than isolated contact.

Flick's topographic study of phthisis in the Fifth Ward of the city of Philadelphia, extending over a period of twenty-five years, shows conclusively that consumption obeys the laws of infectious and contagious diseases. His researches furnish incontestable proof that tuberculosis is limited to *centers*, and each case owes its existence to previous cases in the same house or locality; that a house which has had a case of consumption will probably have others within a few years, and may have a large number of cases in rapid succession; and that approximate houses are considerably exposed.

That tuberculosis in adults requires, as a rule, prolonged contact is evidenced from the fact that husbands have been observed to contract the disease from their wives, and the latter, since they are more constantly confined in the house, to become infected more frequently from the former. Weber has observed the case of a tuberculous husband who lost four wives in succession, another who lost three, and four others who lost two each. The statistical studies of Cornet, Niven, Baer, and others show that the disease spreads through factories, prisons, cloisters, and even among the physicians, nurses, and attendants in hospitals for the reception of tuberculous patients, producing a mortality rate from this disease ranging from 45 to 75 per cent. Seventy-three per cent. of nurses up to the age of fifty die of tuberculosis (Whittaker). Those who are engaged in making the beds, dusting and sweeping the rooms of patients are most exposed; and, on the other hand, better hygienic living among these classes of individuals, and improved sanitary arrangements in prisons, institutions, and hospitals have been found to reduce the death-rate decidedly. This result is to be accounted for as follows: (a) There is thus established a greater tissue resistance to the *Bacillus tuberculosis* on the part of the persons exposed; and (b) the germs are thus more sparsely disseminated. Obviously, then, in institutions in which the proper sanitary precautions are used there may be few if any instances; and from the records of the latter facts opposed to the contagious theory of the disease can readily be furnished. Moving picture exhibitions have been proved experimentally to be potent means for transmission of tuberculosis through bacilli expelled in coughing, speaking, and laughing by individuals with open tuberculosis.

(2) **Infection by Swallowing.**—(a) Baldwin states that "at present the figures suggest that one-quarter of all cases of tuberculosis, in children at least, receive the infection by way of the gastro-intestinal tract, either simultaneously with or independently of the ways of entrance." That the milk of tuberculous animals contains the bacillus and that the use of contaminated milk may infect the human subject are well-established facts. Gerlach and Klebs long since observed the occurrence of the disease in animals fed with milk from cows affected with the so-called "pearl disease." It is not even necessary that the animal infected should have tuberculous mammitis (Ernst), though some are of contrary opinion (Flick, Sidney, Martin, and others). The exact frequency of this mode of infection is not known. Infected animals, especially cows and pigs, that suckle their young very frequently transmit the disease to the latter, the infection usually resulting in intestinal and mesenteric tuberculosis. The bacillus is, in this instance, swallowed and finds lodgment in the *primæ viæ*. The tubercle bacillus is able to pass through the intact mucous membrane; this takes place most readily during the digestion of fats (Ravenel). Bang has even shown that butter made from the milk of tuberculous cows may be infectious (*vide* also Bovine Tuberculosis, p. 230). This explains adequately why abdominal tuberculosis is frequent in children.

(b) The *meat of a tuberculous animal* (e. g., cow, pig, or fowl) may rarely be infectious, but the bulk of experimental evidence would seem to show that unless the parts consumed are the seat of tuberculous deposit, infection does not follow. D. H. Bergey holds that the lower mortality from this disease shown by the Jewish race is ascribable to their careful *meat inspection*. Again, the possibility of contamination during the course of preparation for the market and during transportation must be recollected. The experiments of Aufrecht, Chauveau, Klebs, Parrot, Trappeiner, and others show that tuberculosis may be communicated by incorporating with the food the expectoration from tuberculous patients. The introduction into the stomachs of cattle and goats of a single quantity of virulent bacilli is followed regularly in from thirty to forty-five days by the development of tubercles at the tops of the lungs (Calmette and Guérin).

(3) **Infection by Inoculation.**—Tuberculosis may be transferred by direct inoculation, as shown originally by Villemin's beautiful experiments upon the eyes of guinea-pigs. Infection may take place, though this is rare, through slight cutaneous lesions (cuts, fissures, excoriations), as the result of accidental inoculation of tuberculous matter. In this manner there is produced a local tuberculosis of the skin. Rarely the contagion is conveyed by the lymphatics to the glands in the vicinity, but practically never gives rise to pulmonary or wide-spread tuberculosis. Persons who follow certain occupations are more or less liable to this mode of infection—e. g., butchers, handlers of hides, dissectors of dead bodies, and, rarely, surgeons. Rare instances occur in divers ways (the bite of a consumptive, a cut from a broken spit-glass, or even from his pocket-knife, as I have seen in one instance).

The handkerchiefs, body- and bed-linen of the patient may infect by inoculation those who handle or wash them frequently, if they chance to have a fissure or excoriation upon the hand. No doubt *lupus* also arises in the same way. Czerny has reported 2 cases of infection by transplantation of skin; Collings and Murray, 3 cases by tattooing (?). The contact of the lips of tuberculous operators with surgical wounds (as in sucking the latter) may transmit tuberculosis, as in the performance of the rite of circumcision. Ravenel reports 3 cases of accidental inoculation of the skin in man with the bovine tubercle bacillus.

(4) **Direct Hereditary Transmission.**—In exceptional cases the bacillus is found in the fetus *in utero*. It is possible but highly improbable that the tubercle bacillus may have been carried to the fetus by the semen. Cases of direct transmission that have been traced occurred through the mother. Such instances of placental transmission are of but little importance, according to Schmorl, in explaining the origin of tuberculosis in later life. Tuberculosis in the suckling is rapidly fatal, never remaining latent, is the dictum of this author. However, the views of Baumgarten upon this question should be accorded careful consideration. This author believes that the contagion may be transmitted and become pathogenic at a variable period after birth—first, because the affection is very frequent in young children, even during the first months or weeks of life; and, second, because certain structures, not apt to be accidentally infected, are commonly the seat of tuberculous lesions in children—the bones and joints. After birth the bacillus may at any time either lose its vitality or take on a luxuriant growth. It is not known, however, in what percentage of these cases the lungs, intestines, peritoneum, and lymph-glands are free from tuberculous lesions. Küss disputes the theory of the latency of the tubercle bacilli, and contends that latent foci do not exist before the age of three months; that they are rare before the first year, when they mature progressively.

Two facts deserve to be here emphasized: First, that a child born of tuber-

culous parents is more receptive than one born of healthy stock; and second, that it is more liable to accidental infection.

PREDISPOSING CAUSES.—(1) **Race and Nationality.**—The effect of nationality upon the receptivity to tuberculosis can be studied advantageously in America on account of the cosmopolitan character of the population. The tuberculous tendency on the part of Indians of this continent, even in the most favorable climates, is universally acknowledged, and the fact that the negro race is highly receptive to tuberculosis is also well known. It is more than twice as common in the African as in the white, and still more prevalent with the Indian (W. L. Rodman). At present the number of tuberculous Indians is 24 per 1000 population. Sears found that in 200 cases of tuberculosis nearly 50 per cent. belonged to the first and second generations of Irish immigrants.

(2) **Hereditary Predisposition.**—The percentage of cases in which heredity can be traced has been variously estimated at from 10 to 40. As before intimated (*vide Direct Hereditary Transmission*), a child reared by tuberculous parents runs a great danger of being infected accidentally; and again, a person living in an infected house (with or without the presence of a tuberculous patient) is very liable to become infected, whether his antecedents give a tuberculous history or not. It follows that a correct estimate of the number of cases of phthisis in which hereditary influence plays an etiologic part cannot be obtained. Too much importance has heretofore been attached to the influence of inherited constitutional peculiarities to the exclusion of other potent factors, especially an infective environment. Moreover, a similar degree of predisposition may be acquired as the result of certain debilitating influences (childbirth, defective food-supply, close living- or working rooms). An inherited tendency to tuberculosis is more unfailingly transmitted through the mother than the father. Multiple appearance is commoner in families with tuberculous parents (Dock and Chadbourne). Children begotten of parents who are drunkards, or who suffer from certain chronic incurable diseases (syphilis, cancer, etc) at the time of the birth of their children, are liable to inherit a condition of the system that greatly increases morbidity, unless the tendency is overcome by a proper environment, together with systematic physical training during the first years of life.

The older authors of medical text-books describe two types of conformation—the *tuberculous* and the *scrofulous*. The latter has a heavy figure, thick lips and hands, large, thick bones, and an opaque skin; the former, a light figure, bright eyes, thin skin, oval face, and long, thin bones. The phthisical type of the chest will be referred to in connection with the physical signs of pulmonary tuberculosis. Here emphasis should be given to Cohnheim's view, which is for the greater part correct, to the effect "that the so-called phthisical habit is not an indication of a tendency to, but actually of the existence of, tuberculosis."

(3) **Previous Infectious Diseases.**—Tuberculosis is, however, embraced among the sequelæ of many acute infectious and chronic diseases—influenza, measles, pneumonia, whooping-cough, typhoid fever, cirrhosis of the lungs, and diabetes mellitus. Lues offers a striking predisposition for tuberculosis (Putter). It may develop at any stage of syphilis. Dock and Chadbourne have analyzed 100 cases of adult tuberculosis; it developed rapidly after influenza in 16, and followed pneumonia in 9. Tewksbury¹ and others hold that the influenza pandemic of 1918 will probably cause a marked increase in the incidence of tuberculosis. Personal observations have not, however, shown that the recent epidemic has been responsible for any great increase in patients suffering from tuberculosis, nor has there been seen many cases in which influenza was responsible for the lighting up of a quiescent case. Burns

¹ *Amer. Review Tuberc.*, 1919, iii, 375.

insists that there is a high correlation between dementia præcox and tuberculosis. It seems proper to mention here the fact that certain other diseases are thought by most writers to display an antagonistic effect (chronic valvular disease, pulmonary emphysema, etc.).

(4) **Age.**—This affects predisposition decidedly, though tuberculosis may occur at any or all times of life. Certain forms of tuberculosis are especially frequent in young children (meningeal, mesenteric, and lymphatic). Pulmonary tuberculosis is most common between *twenty* and *thirty*. It is more rare during early childhood and in the aged, and the cases that occur in young children are likely to be rapid in their progress. Tuberculosis in adults usually develops in an organism already infected.

(5) **Sex.**—Predisposition has but slight relation to sex. Females are, however, somewhat more liable than males, and pregnancy in particular is a disposing factor. Again, when tuberculous females become pregnant the progress of the affection is accelerated, and even more so by the period of lactation. Regarding tuberculosis as being pre-eminently a house disease, females are more exposed to contagion than males because they are more closely confined indoors.

(6) **Climate and Soil.**—Humidity of the soil and abundant atmospheric moisture increase the prevalence of tuberculosis. It is especially common in regions in which sudden variations of temperature or protracted cold with dampness prevail. This increase is most probably associated with a heightened vulnerability due to an increased tendency to catarrhal affections of all kinds (Osler). It has been shown that proper drainage of marshy districts has diminished, to some extent, the frequency of this disease (Buchanan), and, on the other hand, mountainous districts are often remarkable for freedom from the disease.

LOCAL CAUSES.—(1) **Occupation.**—Persons whose employment exposes them to different forms of irritating inhalations are particularly liable. In such, however, there is usually first developed a fibroid induration (*vide* Pneumonokoniosis), and the latter in turn is followed by pulmonary tuberculosis. The continual inhalation of an atmosphere laden with noxious particles, such as is met with in ill-ventilated and overcrowded working or living apartments, renders the tissues more vulnerable. Studebaker studied 114 cases at Camp Cody and found that the highest number came from rural districts; the occupation of farming led with 39, mechanics numbered 18, and clerks 14.

(2) **Bronchial Catarrh.**—An acute catarrh of the small bronchi prepares the soil for tuberculous infection. Frequently, however, this is the first step in tuberculosis, since the latter disease almost invariably begins as a local catarrhal process involving the smaller apical bronchi. Here may be pointed out that gastro-intestinal catarrh (of protracted duration—H. M. King) increases the receptivity for tuberculosis.

(3) **Tuberculous Pneumonia.**—In like manner, pulmonary tuberculosis may follow an unresolved pneumonia, but such cases are, as a rule, instances of tuberculous pneumonia primarily.

(4) **Hemoptysis.**—According to some authors hemoptysis is potent in producing pulmonary tuberculosis. It is, however, certain that in most instances in which it appears to precede phthisis and to exert a causative influence, it is, in reality, a symptom of existing tuberculosis.

(5) **Pleurisy** may be, though rarely, the starting-point of phthisis. Its predisposing effect may be attributable to compression of the lung, thus interfering with the respiratory excursions, or to the bronchitis which is frequently associated. Pleurisy sometimes initiates fibroid induration, which may then terminate in a tuberculous affection; but the fact is to be emphasized

that a very large proportion of the cases of apparently primary pleurisy are tuberculous in nature.

(6) **Intrathoracic Tumor.**—Tuberculosis is often associated with intrathoracic tumors, and especially with aneurysm. Fehde has reported 3 interesting cases of the kind.

(7) **Congenital or acquired contraction of the orifice of the pulmonary artery** predisposes markedly to tuberculosis. The lungs are often found to be undersized and ill-nourished from birth.

(8) The statistical investigations of Wotzilka indicate that more tuberculous subjects are unable to breathe normally through the nose than those in health. Rivers emphasizes nasal obstruction, producing mouth-breathing, as a predisposing cause.

(9) **Trauma.**—Injuries to the chest wall, with or without laceration of the lung, are frequently followed by pulmonary tuberculosis. The explanation of this association is to be found in the fact that trauma increases largely the susceptibility of the parts injured by diminishing phagocytic activity—the natural power of resistance. It is a familiar observation in surgical practice that after injuries to, or operations on, joints, tuberculosis, often acute, frequently ensues—in about 8 per cent. of the cases. Traumatism may arouse a latent tuberculosis into activity (Oliver).

TUBERCULOSIS OF THE LYMPH-GLANDS

(*Scrofula*)

Scrofula implies tuberculous infection, and scrofulous material inoculated upon susceptible lower animals, especially guinea-pigs and rabbits, invariably causes tuberculosis. The type of organism (bovine) is, however, less virulent than that derived from other sources, and this explains the slow progress and often latent character of tuberculosis of the glandular system. A major predisposing factor is *age*, this form of tuberculosis preponderating in children. Hecker, from an examination of the records of the Munich Pathological Institute, found that in 147 cases of tuberculosis among children the lymphatics were affected in 92 per cent.; and in young adults tuberculous adenitis is not uncommon. It is rarely met with also during and after the middle period of life. The lesions generally remain limited to the glands first infected—*i. e.*, the cervical, mesenteric, etc., as the case may be—and this for the reason that the natural powers of resistance in the tissues are often able to oppose the march of the destructive forces (*focal infection*). Another predisposing condition is an *acute* or *chronic catarrh* of the mucous membranes.

The cases are all divisible into two groups: (1) Local tuberculous adenitis, and (2) general tuberculous adenitis.

(1) **LOCAL TUBERCULOUS ADENITIS.**—(a) **Cervical.**—This is the most frequent form, and is especially common among children.

Etiology.—Of 2035 persons examined by Valland, enlarged cervical glands were found between the ages of seven and nine in 96 per cent.; between ten and twelve in 96.1 per cent.; between thirteen and fifteen in 84 per cent.; between sixteen and eighteen in 69.7 per cent.; and between nineteen and twenty-four in 68.3 per cent. Tubercle bacilli were found in the cervical lymph-glands in about 68 per cent. of adults. Negroes are found to be more prone to the affection than whites. A. P. Mitchell¹ attributes 90 per cent. of the cases to cows' milk containing bovine tubercle bacilli.

Mode of Infection.—I have stated before that tubercle bacilli are sometimes found on the nasal mucous membrane of healthy persons. The presence of

¹ *Brit. Med. Jour.*, January 17, 1914.

acute or chronic catarrh of the nasopharynx may now lower the resistance of the tissue-cells, so that the bacilli may gain access to the lymph-current, and through the latter to the neighboring glands, setting up tuberculous adenitis. The cervical lymph-glands, however, do not furnish a highly favorable soil for the growth and development of the bacilli, and hence the tendency toward latency.

The *tonsils*, owing to their free communication with the atmosphere, in which there is a wide diffusion of tubercle bacilli, may be primarily infected. Friedman suggests that primary tuberculosis of the tonsils is usually set up by infection through the food. But here also, as in the case of other glandular structures, there is a tendency for the affection to become encapsulated, for the reason that the tissue soil after a prolonged contest generally gains the ascendancy over the invading bacilli. The latter may, however, under certain favorable conditions break down the barriers opposed by nature and effect a lodgment in the cervical glands, or even become widely diffused through the economy. Thus Kinckmann in 64 autopsies found 25 cases of tuberculosis, in 12 of which the tonsils were affected.

A third mode of infection of the cervical lymph-glands is through the medium of slight injuries and abrasions of the skin or certain forms of skin eruptions (eczema, etc) about the face and neck. These serve as doors of entrance for the bacilli, which find their way into the neighboring lymph-glands through the lymph-channels. Compared with infection from within, this mode is much less frequent.

Symptoms.—The main feature is a *visible enlargement* of the affected cervical glands, chiefly the submaxillary. At first the glands are too small to be even palpated; later, they can be felt as small, firm tumors underneath the skin. By and by they appear as visible protuberances, ranging in size from that of an English walnut to that of a hen's egg or even larger. The *skin* over the enlarged gland is freely movable, as a rule; less frequently it becomes adherent—an indication of suppuration. When an abscess forms and is allowed to open spontaneously there remains a chronic discharging sinus. Suppuration is attended with *fever, anemia, and emaciation*. In well-marked cases the separate tumors coalesce, forming large and irregular masses. The affection is usually bilateral, though almost invariably it is more marked on one side than on the other.

Not infrequently, in addition to the enlargement of the submaxillary, postcervical, and supraclavicular glands, there is also involvement of the axillary, as was the case in a fatal instance in my own practice. The patient was a male child, eight years of age, who developed pulmonary tuberculosis. It may reasonably be assumed that the bronchial glands also become implicated, and may excite lung tuberculosis.

The *diagnosis* is based upon the history and the associated evidences (keratitis, conjunctivitis, eczema of the face, nasopharyngeal or bronchial catarrh) coupled with the glandular enlargement. Bacilli have occasionally been found in the purulent discharge from abscesses. Otis applied the tuberculin test and obtained positive reactions in 62 to 69 per cent. The von Pirquet cutaneous reaction may also be employed. Coues urges that cases not quite characteristic of tuberculous cervical adenitis should be regarded as possibly gummatous, and a careful study made to prove or disprove this supposition.

The *course* of this affection is exceedingly slow, often extending over a number of years. Many cases, however, recover after timely surgical intervention. On the other hand, neglected cases are a menace to the life of a patient, since they may be followed by diffusion of the bacilli, with the development of a fatal form of disease.

(b) *Bronchial.*—Tuberculosis of the bronchial glands may be primary,

or secondary to infection of the lungs, and it is commonly preceded by or associated with *bronchial catarrh*, which is its chief predisposing cause. The primary form is met with frequently in young children, the mediastinal lymph-glands being affected uniformly in 127 cases at the New York Foundling Hospital (Northrup).

The bronchial and tracheal glands are the receptacles for all foreign substances, including the tubercle bacilli that are not dealt with by the bronchopulmonary phagocytes. After infection with tubercle bacilli the lymph-glands become swollen, tumefied, and are the seat of caseous change; later they may undergo calcification or proceed to abscess formation. The latter may rupture either into the lungs, into the trachea or the bronchi, or into a pulmonary blood-vessel.

Symptoms.—If a fistulous communication be established with the air-passages, *cough* and *expectoration* of purulent material, blood, and caseous matter containing bacilli will be noted. Schultz claims that lymphocytosis seems to be a constant accompaniment and that it may be increased by the injection of a minute dose of tuberculin. Stoll and Heublein call attention to certain physical signs: “a ‘hilus dimple’ (noted anteriorly over the hilus region at the end of inspiration), dilated veins, parasternal and paravertebral dulness, and, most significant of all, a well-marked whispered broncophony in the interscapular region (d’Espine’s sign).” Roentgenography should not be omitted in doubtful cases.

Secondary infection of the lung may occur in this manner. When rupture takes place into a vessel, systemic infection promptly follows. Tuberculous adenitis involving mediastinal lymph-glands may also lead to infection of the pericardium (tuberculous pericarditis).

(c) *Mesenteric (Tabes Mesenterica).*—This may be *primary* or *secondary*, the latter being common as a secondary infection to intestinal tuberculosis.

The former is rare, however, and the intestinal catarrh with which it is associated is doubtless tuberculous in the vast majority of cases. The mode of infection is by swallowing. The lesions presented are similar to those met with in tuberculous bronchial glands.

The *symptoms* are not always distinctive, and may be entirely negative during the life of the patient; hence the condition is often incidentally discovered during the postmortem examination. The *local symptoms* when marked are due, in the main, to an associated peritonitis. The abdomen is painful and more or less swollen. *Peritoneal effusion* is present, and sometimes sufficient in amount to be detected by the customary physical signs. Large and small *nodules* may sometimes be felt. *Diarrhea* is a marked and an obstinate feature and is usually due to tuberculous intestinal ulcers. *Fever* of an intermittent type is almost constantly present, causing emaciation, and the objective changes (pallor of skin, mucous membranes) due to anemia become pronounced. This form of tuberculosis may persist as a local condition, but there is danger of extension to other organs (pleura, lungs). On the other hand, in the adult pulmonary tuberculosis may be followed by involvement of the mesenteric glands without involvement of the intestines, and in such instances there occurs an extension by contiguity along the course of the lymphatics that pass through the diaphragm, and finally, in adults, primary tuberculous new growths may be met with in the mesenteric glands.

Diagnosis.—A probable diagnosis can usually be made if careful attention be paid conjointly to the symptoms, physical signs, and course of the affection. The detection in a child of a tumor which may be moderately hard, doughy, or even fluctuating will aid materially in the diagnosis, and will also afford evidence of tuberculous disease in other organs. The von Pirquet cutaneous reaction will be found present.

(2) **GENERAL TUBERCULOUS ADENITIS.**—This term implies tuberculous disease of the lymph-glands throughout the body, with little if any involvement of other organs; it is a rare condition. The affection may begin as a local tuberculous lymphadenitis, nearly all the rest of the glands of the body becoming secondarily implicated. The primary seat of the trouble is perhaps most frequently the cervical lymph-glands, though in one instance observed by myself the mesenteric glands first became affected, the case terminating in pleuro-pulmonary tuberculosis.

Symptoms and Diagnosis.—There is *protracted fever*, the temperature being of the remittent or intermittent type. *Wasting and debility* are progressive until the patient presents a decidedly puny aspect, while the lymph-glands that are accessible to inspection and palpation are more or less enlarged and manifest a marked tendency to *suppuration*. The affection is usually *chronic*, though very exceptionally it may exhibit an acute course. One of the chief dangers overhanging the sufferer in this affection is that, owing to liberation of the bacilli, the meninges or the lungs may become tuberculous; these cases may also eventuate in death from asthenia. Cases in which the glands are but little enlarged, while the *general features* are marked, are puzzling. On the other hand, when the superficial lymph-glands are greatly enlarged, the affection may bear a striking resemblance to Hodgkin's disease.

ACUTE TUBERCULOSIS

This form of tuberculosis is characterized anatomically by the rapid development of miliary tubercles in many and widely separated parts of the body. In some instances the new growths are pretty evenly distributed through all the organs of the body, manifesting the clinical symptoms of an *acute general infection*. In other instances there is a tendency to centralization of tuberculous growths, as, for example, in the lungs (pulmonary variety) or in the meninges of the brain and spinal cord (meningeal variety).

Pathology.—The fact is to be emphasized that somewhere in the body there is an old tuberculous focus. Apart from this primary lesion, the anatomic changes consist in the widely disseminated miliary tubercles. Their most frequent seats are the lungs, liver, and spleen; less commonly, the marrow of the bones, the heart, the choroid, and the meninges. In some of the organs, particularly the meninges, lungs, etc., the tubercles may be readily perceived by the naked eye, while in others they frequently cannot be detected without the aid of the microscope. It must not be forgotten that in some of the more protracted cases the nodular tubercles may grow into foci of considerable size, ranging from that of a lentil to that of a pea.

Etiology.—This has been, in the main, given in connection with the general etiology of tuberculosis (*vide supra*), though a few special points remain to be adduced. The acute forms of tuberculosis are decidedly more frequent during infancy and childhood than during adult life, and with few exceptions the cases are secondary to a local tuberculous focus in one or more lymph-glands (tracheal, bronchial, mesenteric) or in the lungs, which breaks into a blood-vessel, whence the bacilli are disseminated throughout the body. Out of a total of 224 traced cases, "3 per cent. had terminated with meningitis and 4 per cent. in miliary tuberculosis" (Wallgren). More rarely a pre-existing tuberculous focus in the kidneys, the bones, or the skin may give rise to the affection. The occurrence of certain other acute infectious diseases (such as measles, whooping-cough, influenza) in children, and typhoid fever and lobar pneumonia (especially with delayed resolution) in adults, may be followed by acute tuberculosis.

Clinical History.—That miliary tubercles may exist in many organs

of the body (liver, heart, etc.) without giving rise to symptoms is a noteworthy fact. Cohnheim and Manz have discovered miliary tuberculosis of the choroid with the aid of the ophthalmoscope alone.

The following forms of the disease may be distinguished:

GENERAL MILIARY TUBERCULOSIS

(a) TYPHOID FORM

The **symptoms** are those of a general infection of the body, there being in most cases a period of *incubation*, during which the patient complains of malaise, headache, chilliness, feverishness, and increasing debility. Rarely the *onset* is comparatively *sudden*. The reaction of the nervous system against the poison, which is now scattered to all parts of the body, is shown by such symptoms as the *fever*, which rapidly increases, a *rapid, feeble pulse*, and *mental dulness* or *delirium*. The *tongue* becomes dry, and sometimes also brown. The *respirations* are accelerated, and there is more or less *cyanosis*, with which symptom is associated a peculiar and *characteristic pallor* of countenance. Coincidentally with the febrile exacerbations the *cheeks* wear a circumscribed blush. Among the rarer early symptoms is epistaxis. The patient soon becomes either profoundly prostrated or anxious; if, as sometimes happens, the course is protracted, *weakness*, *anemia*, and especially *emaciation* are well marked and assume diagnostic importance. These cases sometimes pass into the pulmonary or the meningeal form, the patients often succumbing speedily to such localized developments.

Fever.—The temperature usually pursues a high range, although there are a few cases in which the entire course is afebrile. Again, it occurs not infrequently that the temperature is normal or nearly so for a short period. The usual temperature-curve ranges at first between 102° and 104° F. (38.8°–40° C.), and then continues to rise, with the development of the serious general condition in a way exactly similar to that observed in typhoid fever. In many instances the fever is irregularly remitting, at least at intervals, if not so constantly. Thus, periods of irregular fever may alternate with others of continued, and later deeply remittent or distinctly intermittent, fever.

Nervous Symptoms.—In most cases the nervous symptoms are not prominent. In smaller number headache, vertigo, delirium, and often stupor become marked at an early stage and may persist. They are due to the general infection.

Circulatory System.—The pulse is small, low systolic and diastolic pressure, and its rate is out of proportion to the fever, varying from 100 to 140 or higher. It may become irregular, particularly if the meninges be involved. The total leukocyte count is often decreased with a relative increase in lymphocytes.

Respiratory System.—The breath is somewhat hurried and labored; there is a cough, but it is not annoying as a rule; and there is a slight expectoration which is not characteristic. If there be present simultaneously in the lungs an old tuberculous focus the expectoration may be more profuse and typical. The bacilli are also absent from the sputum unless an old tuberculous lesion exists in the lungs.

The **physical signs** are those of a diffuse bronchitis, though signs of consolidation or pleurisy may develop late in the course of the affection. Such signs, however, may be evidences of an old tuberculous affection.

Digestive System.—As before noted, there are anorexia and a dry tongue (symptoms due to the systemic infection), while vomiting may occur at the outset, and excessive thirst is common. The spleen usually becomes enlarged, though only to a slight extent, as a rule.

Ocular Symptoms.—The important symptom presented by the eye is the presence of choroid tubercles. Their demonstration is only possible with the skilled ophthalmologist. Their absence, however, does not militate against the diagnosis of this disease. Tuleson has described an eruption, in cases occurring among children, which consists of scattered, discrete papules about the size of a pinhead, and on these are tiny vesicles with cloudy contents or minute pustules, followed by drying, with slight incrustation.

Diagnosis.—In the table following I have endeavored to contrast points of dissimilarity between this disease and typhoid fever:

ACUTE GENERAL MILIARY TUBERCULOSIS

Family history of tuberculosis, or presence of an old focus.
Evolution of the disease not characteristic.
Epistaxis rare.
Fever-curve of decidedly irregular type.
Pulse rapid, out of proportion to fever.

Respiration rapid and labored.
Face dusky, with peculiar pallor.
Abdominal symptoms are not suggestive.

No characteristic eruption.

Von Pirquet reaction usually positive.
Knee-jerk may be absent.
Choroid tubercles may be detected.
Tubercle bacilli demonstrable in the blood (66.6 per cent.).

Hemorrhage from bowels exceptional.
Perforative peritonitis absent.¹

TYPHOID FEVER

Coexistent with an epidemic or following previous cases of typhoid.

Evolution of the disease is characteristic.
Epistaxis a common early symptom.
Temperature-curve of the continued type.
Pulse often dicrotic; slow in proportion to fever.

Respiration moderately increased.
No duskiness of face.
Abdominal symptoms (stools, enlarged spleen, tympanites, etc.) suggestive.
The eruption (appearing in successive crops) is distinctive.

Widal reaction present.
Knee-jerk never wanting.
Choroid tubercles absent.
Cultures from venous blood show typhoid bacilli. They may also be found in the stools and urine.

Hemorrhage from the bowels common.
Perforative peritonitis often present.

The tuberculin test may prove an aid to diagnosis.

(b) PULMONARY FORM

Though all gradations between the typhoid and the pulmonary types occur, the latter should be recognized and briefly described. It may develop *suddenly*, the ushering-in symptom being sometimes a *chill*, though more frequently there is a *premonitory period*, during which the general health fails materially. Some acute illness, as measles or whooping-cough, in which there has been marked catarrhal bronchitis, often constitutes the point of departure for this variety.

The *respiratory symptoms* are early prominent, and later preponderate in the clinical picture. From the start there is dyspnea, and this gradually increases until the respirations become rapid (40 to 60 per minute). When dyspnea becomes pronounced, the face presents a characteristic cyanotic pallor. The cough at first is moderately severe, but it soon becomes troublesome, being frequent and attended with a slight expectoration, which, however, is non-characteristic.

The **physical signs** are those of bronchopneumonia, and the latter may or may not be preceded by the signs of generalized bronchitis. With the onset of consolidation there appear spots that yield either dulness or a tympanitic resonance on percussion, and bronchovesicular breathing with numerous subcrepitant râles on auscultation.

The **general symptoms** are marked from the beginning. The *fever* is high—from 103° to 105° F. (39.4°–40.5° C.) or often higher. The pulse

¹ See also Differential Diagnosis of Typhoid Fever.

osing affection will aid in its recognition. Tubercle bacilli are perhaps not demonstrable in the sputum unless an old tuberculous lesion is present. Occasionally either tuberculous meningitis or peritonitis supervenes, and aids in removing the doubt, and in a small percentage of the cases choroid tubercles are detectable. These points, together with the more marked general symptoms, will usually enable the clinician to distinguish this variety of tuberculosis from *non-tuberculous bronchopneumonia*.

(c) CEREBRAL OR MENINGEAL FORM (TUBERCULOUS MENINGITIS)

This variety is of quite frequent occurrence, appearing in not less than 50 per cent. of the cases of miliary tuberculosis. When it develops the symptoms referable to other organs than the meninges are in abeyance. With reference to the *etiology*, the fact needs to be emphasized that most cases occur between the ages of two and seven years; it may, however, be met with at any time of life. The affection frequently has its origin in tuberculous bronchial glands (Jacobi), and the history of a fall is common. A few cases have been found to be associated with erythema nodosum. Exceptionally the meninges are primarily involved.

Pathology.—The chief site of the tubercles in children is the pia mater at the base of the cerebrum (basilar meningitis), while in adults the pia at the vertex is more apt to be involved. The membrane surrounding the tubercles may not be inflamed, there being a simple tuberculous deposit. On the other hand, more or less inflammation, with serofibrinous or fibrinopurulent exudation, is generally present in the region of the base. This exudate is usually abundant in the Sylvian fissures, and may find its way to the external surface of the hemispheres. It is gray in color, transparent, and gelatinous, and contains in its meshes the tubercles, which appear as grayish-white bodies, and which in cases of equal severity may be either numerous or scanty. They may be scarcely visible to the naked eye, but may vary from the size of a pinhead to that of a French pea. The branches of the Sylvian artery may be implicated, either owing to the direct pressure of the exudate or to the obliterating arteritis produced by a tuberculous infiltration. The pia looks like wet blotting-paper over the quadrangle at the base (Gray). Elsewhere it is thickened and opaque, though easily detachable. Osler says: "The arteries of the interior and posterior perforated spaces should be carefully withdrawn and searched, as upon them nodular tubercles may be found when not present elsewhere. In doubtful cases the middle cerebral arteries should be very carefully removed, spread on a glass plate with a black background, and examined with a low objective. The tubercles are then seen as nodular enlargements on the smaller arteries." Involvement of the chief vessels that nourish the walls of the ventricles and the ependyma, and stretch from the vermis cerebelli forward over the quadrigemia, explains the constant presence of a turbid fluid in the ventricles, with softening of their walls. As the result of undue intraventricular pressure the cerebral convolutions become more or less flattened, with effacement of the sulci. The cortex, to a variable depth, is generally the seat of red softening, and more rarely of white softening alone. The tuberculous infiltration involves the cranial nerves.

Symptoms.—There is a *prodromal period* which lasts one or more weeks, during which the patient (usually a child) is pale, peevish, has headache and photophobia, and grinds its teeth during sleep; the tongue is coated, appetite impaired, and there may be occasional vomiting, either propulsive or regurgitative. Constipation is present and may be marked. Among rare premonitory symptoms are slight hyperesthesia of the abdomen and a diminished urinary secretion. A tendency to *emaciation* is quite constant. These prodromal

symptoms present variations as to their number and combinations in different cases. In few instances only is the onset acute. The symptoms usually indicate basic meningitis, and at first there is associated considerable mental excitement; later there are pressure-symptoms (caused by the exudate), with total loss of the mental faculties.

(1) **Stage of Cerebral Excitement.**—The *invasion* is generally gradual, or even quite insidious, its most characteristic phenomena being *severe vomiting, marked headache, and chills followed by fever*. Certain other symptoms now arrest the attention, such as extreme irritability, screaming, and great obstinacy, and occasionally drowsiness appears early. When the onset is sudden the disease may be disclosed by convulsions, paralysis, wild delirium, or coma. The established disease exhibits certain distinctive features. The pain is often most excruciating, causing the child to utter short penetrating screams (hydrocephalic cry), and in rare instances the sharp cries may be continuous and lead to physical exhaustion. The headache is increased by light, noise, or movement. Vertigo is common; the pupils are contracted at this period; the face pales and then flushes; the pupils alternately dilate and expand; and the expression is sometimes sad, though more often stupid. Generally hyperesthesia or dysesthesia may appear, and there may be a slight mind-wandering at night, though active delirium is rare. *Taches cerebrales* may be obtained, but are not characteristic. The patient is intolerant of every form of disturbance. All the symptoms of the prodromal stage are now aggravated; slight muscular twitchings and sleep-starts occur; the vomiting is apparently causeless, and may be frequently repeated, and constipation persists.

Fever is present, but is of slow development, and rarely rises higher than 102° or 103° F. (38.0°–39.4° C.) in the evening. The *skin* is dry and harsh. The pulse is slow or moderately accelerated, but soon quickens to 120 or even 130, and later it may be irregular. At times the *pupils* are unequally contracted, and ptosis is usually an early sign.

(2) **Second or Transitional Stage.**—The symptoms of cerebral irritation now abate, the patient becoming more quiet, while mental dulness often supervenes. The vomiting and headache gradually subside, and the child rarely cries out. The abdomen is now distinctly scaphoid and the head occasionally retracted. Constipation is obstinate. The evidences of localized organic foci, such as slight twitchings of the muscles of the face, followed by strabismus, ptosis, or paralyzes of the face or limbs, may appear. Generalized convulsions may occur, and muscular tremors and athetoid movements may appear. Both pupils (or one only) may be dilated as intracranial pressure develops; patchy flushing of the face is common. The respiration is now irregular and sighing.

(3) **The Stage of Paralysis.**—On account of the exudation the mental faculties are abolished, so that the patient is comatose, though convulsions or localized spasms of the muscles in different parts of the body (neck, back, limbs, etc.) may be observed. Optic neuritis develops, while the paralysis of the ocular muscles above noted deepens. The pupils are dilated, the eyes are partly closed, and the eyeballs at intervals slowly and alternately move in a lateral direction. Hemiplegia sometimes develops, and more rarely monoplegia, affecting the face or one of the extremities. There may be paralysis of the third nerve, with involvement of the face, hypoglossal nerve, and limbs on the opposite side (a combination of symptoms first observed by Weber), consequent upon a lesion localized in the internal inferior portion of the crus. Monoplegia of the right side of the face has been observed in a few instances associated with aphasia. Exceptionally aphasia and brachial monoplegia have been combined. The temperature in the early part of this stage usually rises to 103° F. (39.4° C.) or higher, but later it may drop to a subnormal level,

and in rare instances as low as 94° F. (34.4° C.). Immediately preceding the fatal termination the temperature may rise to 106° or 107° F. (41.1°–41.6° C.), the pulse becoming frequent, small, and irregular. Anesthesia comes on with general muscular relaxation.

Occasionally a *typhoid state* (great prostration, dry tongue, diarrhea, etc.) may develop, and Cheyne-Stokes' respiration is almost invariably present preceding the fatal event. Leukocytosis has been observed. Macewen first pointed out that if the patient is caused to assume the upright position with the head inclined to one side, percussion over the pterion gives a tympanitic note which is indicative of internal hydrocephalus. Koplik found this sign present in 34 of 52 cases.

Ophthalmoscopic Examination.—The ophthalmoscopic appearances are—hyperemia of the disk, later the changes belonging to neuritis (swelling and striation) appear, and choroidal tubercles may be detected.

Diagnosis.—This is based largely upon the results of lumbar puncture. A clear fluid under pressure is indicative of tuberculous meningitis, poliomyelitis, cerebrospinal syphilis, brain tumor, or meningismus; cloudy fluid, of meningococcic or pyogenic meningitis of some type, according to De Bois and Neal. The fluid should be examined for the presence or absence of bacteria, the differential cell count made, and chemical tests employed. Turbid fluids show practically no cells, but polynuclears, leukocytes, and pus. In clear fluids there are usually 20 to 30 cells to a field, 90 per cent. of which are mononuclears. The chemical tests include Noguchi's test for globulin, which is present in inflammatory conditions but absent in meningismus. Albumin is present in inflammatory conditions. Absence of reduction of Fehling's solution occasionally occurs in meningitis. The differentiation of tuberculous meningitis from central nervous syphilis, brain tumor, and meningismus, conditions associated with clear spinal fluid, is usually made without any difficulty from the symptoms, signs, and the chemical changes in the fluid. When, however, the tubercle bacillus is not found in the fluid it is frequently impossible to distinguish between the fluids of tuberculous meningitis and poliomyelitis. Likewise the symptoms presenting cerebral symptoms of tuberculous meningitis and poliomyelitis in the early stages closely resemble one another. The following table will show some of the differences between the two conditions:

TUBERCULOUS MENINGITIS	ANTERIOR POLIOMYELITIS
Frequently associated with tuberculosis elsewhere, <i>e. g.</i> , bronchial glands.	History of epidemic; contact.
Prodromes—insidious, headache, anorexia, irritability.	Prodromes suggesting gastro-intestinal or upper respiratory infection.
Fever of slow development.	High fever—sudden in onset with rapid fall.
Transient paralyses.	Permanent paralysis.
Projectile vomiting, night cries.	Usually absent.
Remission and recurrence of symptoms usual.	Rarely any remission.
Impossible to arouse child—in stuporous stage.	Child can be aroused, but at once falls back into stuporous condition.
Leukocytes usually not increased.	Leukocytosis and polynuclear increase usually found.
Spinal fluid—more marked increase in albumin and globulin.	Not so marked.
Fehling's reduced imperfectly or incompletely.	Fehling's solution promptly reduced.
Tubercle bacilli occasionally found.	Never found.

The positive ninhydrin reaction in the spinal fluid aids in differentiating this disease from typhoid fever, pneumonia, septic infections, and, in children,

more common than the previous, especially in children. The evidences of bronchitis affecting the finer tubes, together with consolidation of the lobules to which the tubes lead, are striking. As in ordinary bronchopneumonia, so here, the solidified areas appear as grayish-red masses in the early stage, while later they are of an opaque white. The products that fill the air-cells may caseate and break down, with the formation of irregular cavities that vary in size. When large areas are involved they are the result of the fusion of contiguous smaller areas of heptized tissue. The trouble often begins in the upper lobes and spreads downward, though not infrequently the lower lobes are most extensively involved.

Bäumler has called attention to a type of *tuberculous inhalation pneumonia* consequent upon hemoptysis, the blood and contents of the cavities being drawn into the finer tubes in respiration. This form of bronchopneumonic phthisis sometimes follows pulmonary tuberculosis in the early, though more often in its late, stage. On microscopic examination tubercle bacilli are found, though rarely in abundance, in the infiltrated masses and in the walls of the cavities.

Clinical History.—(1) **Acute Cases.**—Preceding the attack, the patient may have “taken cold” or have been in a run-down state; more often, however, he has been apparently healthy. The *onset* is sudden, marked by a *rigor*, *pain in the side*, *fever*, *cough*, and *systemic prostration*, and there may be *bronchial hemorrhage* which may last one or more days. The total amount of blood expectorated may be considerable. In the majority of cases the *expectoration* is mucoid at first, and then becomes rusty colored, often containing tubercle bacilli, though at first they may be absent and, indeed, not appear until late in the disease. *Dyspnea* appears early, and may soon become extreme, and the fever quickly rises to 104° F. (40° C.) or over. It may be of the continued type, or it may early assume the remittent or hectic type, and with the latter forms of fever, which usually begin about the end of the first week, are associated *night-sweats* and *rapid emaciation*. The prostration of the vital powers is now extreme. The expectoration is more abundant, mucopurulent, and often greenish-yellow in color.

In the course of one or two days after the onset we obtain *physical signs*. Usually, as before stated, there are present the anatomic appearances of acute lobar pneumonia—viz., the complete consolidation of one or more lobes, which is usually followed by signs of softening, provided the patient survives the first week or ten days. The physical signs during the stage of consolidation are precisely the same as in lobar pneumonia. The signs of softening and of cavity will be given in detail below (*vide* Chronic Phthisis).

The *course* is usually rapid, occupying from two to six weeks on the average, though rarely cases that reach the stage of cavity formation are protracted to three or even four months. Considering the brevity of the attacks, the extreme degree of emaciation (shown especially by the hollow cheeks and temples, pinched nose, and thin hands) is truly remarkable. The patient usually maintains a hopeful state of mind, notwithstanding the rapid downward course of the affection, and it may be admitted that recovery is possible. The parts involved are in such cases destroyed and replaced by fibrous tissue, and it should be remembered that the apex is oftenest involved. It may happen that consolidation only is present in the second lobe affected, while in the upper lobe one or more cavities have already been developed. The pleural crepitating friction is often audible before consolidation is complete.

Diagnosis.—The onset, symptoms, and course during the first week may be those of ordinary lobar pneumonia, but in some cases certain symptoms may arise which will excite suspicion of their tuberculous character in the early stage. Thus, hemoptysis rarely occurs in a pneumococcus infection,

and the appearance of the patient, as well as his previous and family history, may also be of a confirmatory character. The points of discrimination have been fully set forth in the section on Lobar Pneumonia (pp. 112, 113).

(2) **Subacute Cases** (rarely acute).—The *onset* is less sudden than in the former type, while the patient's antecedent condition may either be good or below the *standard*. At the beginning he has *repeated chills*, though *hemoptysis* may be the first symptom which indicates a pre-existing tuberculous focus. The *fever* rises high, and is apt to be irregular from the start; the *pulse* and *respirations* are rapid, and there is a *mucopurulent expectoration* which may either be profuse or scanty. Occasionally it is fetid, and the sputa may early contain *elastic fibers* and *tubercle bacilli*, though more often these are noted after the affection has become fully established. During the progress of the case, also, hemoptysis may arise. Later, drenching *night-sweats* increase the exhaustion and emaciation, which speedily reach an extreme degree, and soon or late a typhoid condition of the system is developed.

The *physical signs* are, at first, those of general bronchitis, with or without indications of pleurisy. Later, small areas of consolidation, which often increase in size, are indicated by impaired percussion resonance or dullness and by bronchovesicular (rarely tubular) breathing, with subcrepitant râles. These signs may be unilateral, though more often they occur bilaterally. In many cases softening with cavity formation ensues, with the usual physical signs of this condition.

Course and Duration.—For some time the patient may remain out of bed, although in most instances the disease constantly progresses. Less frequently there are exacerbating periods and remissions. Rarely these cases recover with a loss of more or less lung tissue. Again, the condition may pass into chronic phthisis. It is important to recollect that the local lesions may become extensive as the result of fusion of small consolidated masses until an entire lobe is involved, and when this occurs the symptoms and course simulate those of the acute type. The *duration* ranges from two to eight weeks or more.

Diagnosis.—This variety is frequently confounded with non-tuberculous bronchopneumonia, and the chief distinctions will be mentioned in connection with the latter disease. *Bronchiectasis* may be accompanied by emaciation, fetid expectoration, night-sweats, and the signs of cavity, and this disease has been mistaken for acute phthisis. Important in the recognition of the latter, however, are marked fever and emaciation. Moreover, the physical signs are more frequently referable to the apices, and the disease is more steadily progressive, running a shorter course than bronchiectasis. The sputum contains tubercle bacilli.

Acute Bronchopneumonic Phthisis in Children.—The belief that the form of bronchopneumonia that so frequently follows certain infectious diseases (measles, whooping-cough, etc.) is in the majority of instances tuberculous has been steadily gaining. Osler recognizes three groups of cases: (a) Those in which the child suddenly becomes ill while teething or during convalescence from fever, with high temperature, severe cough, and the signs of consolidation of one or both apices. Death may occur within a few days. To the naked eye the lesions do not appear to be tuberculous. (b) In this group the children show the ordinary symptoms of bronchopneumonia, and the cases are more protracted, death occurring about the sixth week. (c) The child feels ill during convalescence from an infectious disease, fever, cough, and dyspnea being present. The intensity of the symptoms abates within a fortnight, and the physical examination shows the presence of diffuse bronchitis with scattered minute areas of consolidation. Many of these cases develop into chronic phthisis.

CHRONIC TUBERCULOSIS

(*Chronic Pulmonary Tuberculosis; Chronic Ulcerative Phthisis*)

This form is much more common than the acute, the term embracing subvarieties to which attention will be incidentally directed. Its most typical clinical form follows a mixed infection as a result of a septic element superadded at some time to the primary tuberculous infection.

The causal factors have been detailed under General Etiology.

Pathology.—The pathologic characters of tuberculosis in general have been already presented, but it will be necessary to describe briefly the special anatomic conditions met with in *chronic ulcerative phthisis*.

In nearly all fatal cases the most advanced and extensive lesions are found near the apex, and, as a rule, the entire upper lobe of one of the lungs is implicated. In addition, it is observed that the destructive process has extended to the lower lobe of the same side, and later to the apex of the opposite lung. Though both lungs are affected in fatal cases, they represent different stages of the disease. The case is very different in an old and cured tuberculosis of the lungs, such as is frequently met with in persons who have died of some other affection. Here the lesions may occupy but a small part of one lung, and usually near the summit.

Kingston Fowler has investigated the question of the points of election and paths of distribution of the lesions in chronic phthisis, and has found that the primary lesion is not, as a rule, at the summit of the upper lobe, but that it occurs from 1 to 1½ inches (2.54–3.79 cm.) below this point and near the postero-external borders. Favored by normal respiration, the lesions advance downward, so that on physical examination the first evidences of disease are to be found posteriorly over the lower part of the supraspinous fossa, while anteriorly the early signs are met with immediately below the middle of the clavicle, extending along a line running about 1½ inches (3.79 cm.) from the inner end of the second and third interspaces. The starting-point, though less frequently, may also be indicated by physical signs in the first and second interspaces below the outer third of the clavicle, with subsequent downward extension.

From personal observation of the postmortem lesions of this disease, and from my studies at the bedside, I feel convinced that the initial lesion is frequently located anteriorly and near the apex, corresponding on the chest walls to the clavicle and the supraclavicular spaces. This site has seemed to me to obtain more often on the right side than on the left. Kingsley has shown that when the lower lobe becomes involved the consolidation begins about 1½ inches (3.79 cm.) below its apex posteriorly, and corresponding externally to a spot opposite the fifth dorsal spine. From this point it spreads downward and laterally in a line following the border of the scapula "when the hand is placed on the opposite scapula and the elbow rests above the level of the shoulder." The middle lobe on the right side is usually invaded by direct extension from the upper. The seat of primary infiltration may even be the lower lobe, but this is rare. Cole¹ has found lesions at the root to precede parenchymal changes.

The relative frequency of involvement of the two sides varies according to different authorities. A careful analysis of my records and those of other observers shows that out of a total of 1236 cases 726 occurred on the left side and 510 on the right.

In all cases the primary lesions are due to *tuberculous infiltration*, which at first is confined to certain lobules, though it may later involve extensive areas of lung tissue (*tuberculous bronchopneumonia*). In most instances

¹ *Amer. Jour. Med. Sci.*, July, 1910.

the starting-point of the morbid changes is in the small bronchi and also, according to Payne, the inside of the alveoli. Soon the bronchioles and the corresponding air-cells become blocked with inflammatory products. These areas then undergo caseation and present the usual opaque, grayish-yellow appearance, a cross-section of these yellow nodules showing the central bronchus usually plugged with exudate and surrounded by caseous matter. Softening and sometimes complete liquefaction, with expectoration or absorption of the altered morbid products, may take place, and this disintegration is associated with *ulceration* in the wall of the bronchus, consequent upon secondary pyogenic infection, and a resulting formation of small *cavities*. Ulcers may form in the bronchioles before necrotic processes supervene, and they are generally shallow, with sharply defined edges. Heise and Sampson have described a peribronchial form, rarely opening into a bronchus (non-ulcerative). Recovery may ensue as the result of *calcification* with encapsulation of the cheesy masses, or the affected area may undergo *fibroid transformation*—a conservative process and one that may lead to actual cure. It often happens, however, that old and apparently healed tuberculous lesions undergo ulceration, when the calcareous masses (pulmonary calculi) may be dislodged and expectorated, and the more rapidly the caseous masses are formed, the more liable are they to softening. Surrounding the healed areas the tissue may be the seat of atelectasis, though more often of emphysema. Destruction of lung tissue also results from interstitial inflammation with the formation of new connective tissue, the latter in turn compressing and finally obliterating the alveoli.

CAVITIES (*Vomicæ*).—These result chiefly from progressive necrosis and ulceration. They are formed mostly by dilatation of the bronchi, whose walls are tuberculous and suppurating. But they may also arise independently of the bronchi. Cavities vary largely in number, size, and form. They are often multiple, though usually not far removed from one another, and unite as they increase in size. In this way large cavities, with irregular walls, involving the whole of one lobe and even an entire lung (except the extreme anterior margin), may be formed, and small pockets connecting with the bronchus may thus originate.

Vomicæ may be classified as (1) progressive and (2) non-progressive.

(1) The **progressive** are divisible into (a) new cavities and (b) old cavities.

(a) *New cavities* have soft, necrotic, friable walls so long as the destructive processes are rapidly progressing, and the same state of things prevails in the cavities of acute phthisis. They may develop near a healed focus or near old cavities with limiting walls, and when situated near the periphery of the lung they may rupture into the pleura, causing pneumothorax.

(b) *Old cavities*, as a rule, have sharply defined walls that vary considerably in thickness. At first they consist of a fibrovascular zone, which has an inner suppurating surface; subsequently the lining of this zone is converted into an exfoliating membrane. The contents of *vomicæ* are mucopurulent or purulent, and often consist of a shreddy and sometimes a bloody fluid. Rarely they are gangrenous. Cavities also contain tubercle bacilli and other microorganisms. Percy Kidd has studied the question of the relation of tubercle bacilli to tuberculous pulmonary lesions, and states that they are invariably present in newly developed tubercles and fresh cavities, but frequently absent in old nodules. Trabeculæ composed of blood-vessels and remnants of pulmonary tissue often traverse the cavities. In old cavities excavation may be complete, not a vestige of normal or diseased tissue remaining in them, though the blood-vessels, many of which are beaded by small aneurysmal dilatations along their course, are the last to disappear. Their removal is affected by an obliterating inflammation. Rupture of these miliary aneurysms or the

rosion of a large vessel gives rise to copious hemoptysis. Cavities having tense walls may also increase in size by encroaching upon the surrounding issue, huge cavities often having thin, tense walls. But, wherever situated, they usually begin toward the summit of the upper lobe. Another common seat is the middorsal region.

(2) **Non-progressive Cavities.**—Quiescent cavities are usually small, though variable in size, according to the stage at which the process of contraction is arrested. Medium-sized and large vomicæ do not become totally occluded. They may be multiple, though more often perhaps single, and associated with them may be observed dense, fibrous nodules representing healed foci. Their interior may be lined with a smooth, cuticular structure resembling mucous membrane.

Interstitial Pneumonia.—In the course of chronic phthisis interstitial inflammation of two sorts will most probably arise: (a) A consolidation excited by the tubercle bacilli themselves, and hence manifesting a *destructive* tendency; (b) A slowly developed *interstitial pneumonia* which aims at *arresting* the progress of the affection. It develops in close proximity to caseous masses and around cavities. The new connective tissue thus formed in obedience to the well-known pathologic law tends to contract secondarily, and thus vomicæ are often partly, though seldom entirely, obliterated. The shrinking of the connective tissue may also result in compression, and finally in the destruction of pulmonary tissue, just as in a tuberculous inflammation. The process in this instance, however, is, on the whole, conservative and reparative.

Disseminated Tuberculosis.—*Miliary Tubercles.*—This form has for its chief characteristic miliary tubercles, which are scattered not only about the tuberculous area, but also throughout the rest of the lung, and usually in the lower lobe. Most of the tubercles undergo fibroid or fibrocaseous change. These minute, hard, gray or grayish-yellow nodules vary in size from a mustard-seed to that of a pea, and lung tissue that is more or less studded with chronic miliary tubercles is apt to look pale, while the surrounding air-cells are *emphysematous*. The condition may lead to pneumonia, and the whole aspect then becomes altered. Here, as before described, fusion of miliary tubercles results in larger masses which become caseous, and hence the method of cavity formation is identical with that observed in tuberculous bronchopneumonia. In the disseminated form tubercles may also be found in many other organs than those indicated (pleura, trachea, larynx, bronchial and other lymphatic glands, peritoneum, spleen, kidneys, liver, brain, mucosa, testes, etc.).

Lesions of the Pleura.—This membrane is hyperemic and coated with fibrinous exudation coextensively with the affection of the parts in chronic ulcerative phthisis. The pleural membranes are only more or less thickened by organized adhesions, but in the latter and also in the pleura tubercles or cheesy masses may be found. Simple and other forms of pleurisy are met—sero-fibrinous, purulent, and hemorrhagic.

Lesions of the Bronchial Glands.—At first these are enlarged and edematous, containing tubercles, and later they present foci which often undergo purulent disintegration and sometimes calcification. Other lymphatic glands than these may be affected (mesenteric, etc.).

Lesions of the Larynx.—The larynx is frequently the seat of tuberculous infiltration and ulceration, particularly in certain parts, such as the vocal cords, posterior wall, and aryepiglottidean folds.

Lesions of the Heart.—Tuberculous endocarditis is present in about 5 per cent. of the cases, and congenital stenosis of the pulmonary orifice is noted in not a few instances (Chevers). The right heart is often hypertrophied or dilated.

tack. There is no mistake in diagnosis more commonly made in malarial regions than to ascribe such cases to paludism.

(c) *With Hemoptysis*.—This symptom may invite attention to lung trouble. Müller states that hemoptysis was an early symptom in 170 of the 875 patients at the Davos German Sanatorium, and was twice as frequent in the male as in the female. The amount of blood lost is either considerable or repeated slight hemorrhages occur. In most cases the clinical picture of incipient pulmonary tuberculosis is revealed, pursuing its accustomed course immediately after the occurrence of the hemorrhage. The physical signs may be latent for a time, and, while they are usually located in the subapical area, they may assume the guise of a pleurisy in the infrascapular region. A slight tuberculous lesion is present in these cases preceding the occurrence of the hemorrhage.

The symptoms are (1) *local* and (2) *general*.

(1) *LOCAL*.—(a) *Pain*.—This is absent in many cases of chronic phthisis and in others it may be moderately severe. It is seated usually at the base, laterally or anteriorly, and not rarely there is pain of a lancinating character in the interscapular region in the early stages of the affection. This symptom is of diagnostic worth only after other forms of pain (rheumatic, neuralgic) have been excluded. The most common cause of pain is pleuritis, with or without pleuritic adhesions; it is increased on deep breathing and coughing. Intercostal neuralgia and pleurodynic stitches may also develop soon or late. Tenderness on pressure with the right forefinger (algeoscopy), which causes the patient to exclaim or make a grimace, or merely a contraction in adjoining muscles, was present in 77.9 per cent. of 200 cases studied by Francke, while only one-third of these patients complained of spontaneous pain.

(b) *The Cough*.—This may be looked upon as an essential feature, though in a few instances it may be slight or even wanting throughout. Its severity bears no constant relation to the extent of the pulmonary lesions, but rather to the degree of sensitiveness of the patient. It is dry and hacking at the beginning, and, if the larynx be involved, the cough is marked and of a hoarse quality. It is most pronounced at certain periods of the day—viz., on lying down at night and on awakening from sleep. Paroxysms may occur after meals and induce vomiting. The cough is at times debilitating in its effects.

(c) *Expectoration*.—At the beginning the sputum is scanty and mucoid, rarely hemorrhagic, or it may be merely streaked with blood; later it may become mucopurulent, and the appearance of small gray or grayish-yellow flocculi first suggests the nature of the affection. With the onset of the stage of cavity formation the sputum becomes more abundant and more distinctly purulent, and, after the formation of cavities of any size, airless, opaque, and nummular (coin-shaped) masses are expectorated. The latter are greenish-gray or greenish-yellow in color, and sink rapidly when discharged into water. They are often mingled with more or less bronchial secretion, and are sometimes observed in pure bronchitis. They may even be absent, and the expectoration be merely purulent. The opening of a fresh cavity may be followed by very free expectoration. The sputum is sometimes fetid, and exceptionally it is horribly offensive, varying greatly in amount in different cases and at different stages of the disease. In certain cases it is absent throughout the greater portion of their course, and is especially apt to be slight in children and old people. In such instances it may be impossible to collect sufficient sputum to examine for bacilli.

Microscopic examination discovers alveolar epithelium (particularly in the earlier stages), pus-cells, blood, fat-globules, elastic fibers, and *tubercle bacilli*, the detection of the latter being the most important factor in the diagnosis. It may be safely stated that the finding of bacilli in the sputum is *prima facie*

stage of cavity their number is usually increased, and sometimes they are quite numerous.

The demonstration of *elastic fibers* is also an important aid to diagnosis. Fenwick's method is the following: Boil the sputum with an equal quantity of a solution of caustic soda (gr. xv-℥j—1.0-30.0); pour the product into a conical glass and fill with cold water. The sediment is subsequently examined with care for elastic fibers.

The *form* and *appearance* of the elastic threads differ according to their special source. If they come from the alveoli, there is an interlacing of the fibers which may preserve the globular contour of the air-cells. If they come from the blood-vessels, they are single and elongated, or two or three of the fibers may be arranged side by side. Elastic tissue derived from the bronchi has a similar appearance.

The presence of elastic fibers furnishes incontestible proof that destruction of lung tissue has taken place. To show that this loss of structure, however, is due to tuberculosis, we must exclude abscess (rare) and gangrene of the lungs—diseases in which it also occurs.

(d) *Hemoptysis*.—This symptom of phthisis will be spoken of under Diseases of the Lungs, but its importance as a diagnostic feature of this disease makes



Fig. 21.—Elastic fibers (after Strümpell).

special reference to it here absolutely necessary. It is present in the majority of cases. Gabrilowisch found that of 380 patients, 213, or 56 per cent., had hemoptysis. My own figures show 36.6 per cent. (*vide* Hemoptysis, p. 538), but Lord, who reviewed 549 clinical cases of hemoptysis and 307 cases with necropsy, notes the occurrence of hemoptysis in about 60 per cent. of cases at some time in their course. The sputum may be merely blood stained, or the hemorrhage may be excessive and prove rapidly fatal, though hemoptysis is rarely the direct cause of death in tuberculosis. Slight hemorrhages are usually produced by mere hyperemia, and are most apt to occur during the early stages; while severe bleedings are produced by the erosion of a blood-vessel or rupture of a small aneurysm, and are most prone to occur during the stage of cavity. In certain cases hemoptysis is frequent.

A third or capillary form of hemorrhage may occur in phthisis with cavity formation, and in this variety, which is of a rather frequent occurrence, the purulent sputum is uniformly stained with blood. It may also be nummular, but presents a reddish-brown or chocolate color. The *exciting cause* is seldom obvious, though in not a few instances aggravation of the cough, and in others great mental excitement, would appear to excite bleedings. Slight hemorrhages often, and severe ones rarely, afford more or less relief to the pulmonary condition. On the other hand, severe bleedings usually exert an unfavorable influence, being followed by debility and anemia. Moreover, in numerous

cases hemoptysis is followed by a more rapid extension of the local lesions, with corresponding aggravation of the local and general manifestations. The fact remains, however, that the effect of severe hemoptysis upon the progress of chronic phthisis is by no means always untoward. In a case of my own there occurred periodically copious spontaneous bleedings (in spring and fall) for three years, which were as regularly followed by marked improvement for a period of three or four months. The physical signs of phthisis then developed. In a large number of cases of pulmonary tuberculosis the transition from warm to cold or cold to warm seasons corresponds with increased cough, hence with increased pressure in the pulmonary circulation; and so bleeding is also favored, particularly in those having a hemorrhagic tendency.

(e) *Dyspnea* is present, but is not a marked feature, as a rule, despite advanced pulmonary lesions. Perhaps the chief reasons for a lessened demand for oxygen on the part of the system are—first, the slow and gradual manner in which the lesions develop; and second, the pronounced bodily wasting. The *respirations*, however, are moderately increased in rate, averaging from 20 to 30 per minute, and this compensates admirably for the diminished breathing space. The dyspnea may be greatly intensified, however, as the result of intercurrent pneumonia, pleurisy, active exertion, or great mental excitement, and toward the close of fatal cases the most intense dyspnea may be manifested.

Physical Signs in the Stage of Infiltration.—*Inspection* gives most important results. The paralytic or phthisical thorax is generally presented to view. It is flat, particularly the upper half; the intercostal spaces are wide; the ribs slope at a sharp angle from the sternum, making the epigastric angle acute and producing elongation of the chest. The same sharp inclination downward from the vertebral column is observed laterally and posteriorly. The angle of Louis is prominent, and the depressions (supra- and infraclavicular, intercostal) are deepened, the costal cartilages being often prominent and the sternum, particularly in the lower part, sometimes much depressed or even concave (funnel breast). The scapulæ stand out prominently and may be distinctly winged. A second type of paralytic thorax is narrow and long. Pulmonary tuberculosis may, however, arise in chests of apparently normal build. The paralytic thorax is often a resultant of developed phthisis. In subjects of obesity the phthisical thorax may be concealed. The deformity due to occupation, as leaning over a desk, may ape the paralytic chest, and, finally, it may be the result of extreme emaciation. With the development of phthisis the depressions of the side affected are relatively deeper, while the clavicle often stands out prominently.

Defective expansion is observed early, and usually at the apex of the side first affected; subsequently this may be more general, and finally bilateral. To note the motions of respiration with precision the examiner should occupy a position exactly in front of the median line of the patient's body. The difference in the movement of the two sides often becomes more apparent on deep respiration than on quiet breathing, and while at rest the respirations are almost normal, but exertion decidedly increases their frequency.

Palpation.—Testing the expansion by palpation gives better relative results than does inspection. To determine the comparative movements of the apices the extended hands should be so placed (by allowing them to diverge below) that the tips of the fingers touch the lower border of the clavicle, and then the patient should be asked to breathe deeply, though slowly. The expansion in the supraclavicular spaces is tested by standing behind the patient and using the tips of the fingers, or by allowing the two first fingers of each hand to pass parallel with the clavicles. In this way "lagging" over

the apex will be the first symptom recognized, and may for some time be the only one. Webb's sign, a deviation of the trachea to the right or left as palpated just above the suprasternal notch, is a valuable finding, particularly in old healed lesions in which contractures have pulled the trachea toward the affected side.

Tactile fremitus is early increased with oncoming consolidation, though it is normally more marked at the right than at the left apex. If there be thickening of the pleura, however, it is diminished, and if there be pleural effusion it may be absent.

Mensuration.—The difference between the measurement of the chest in inspiration and expiration in any person of average health should be not less than 3 inches, and a difference below $2\frac{1}{2}$ inches points strongly to tuberculosis. The data thus gained are more important than the shape of the thorax.

Percussion.—Resonance is deadened more and more as consolidation progresses. If the consolidated areas are minute, however, the percussion-note may be unchanged, and as the air-cells surrounding the latter are often emphysematous and relaxed, it may be somewhat tympanitic. The tympanitic sound and deadness may be intermingled, giving rise to the so-called tympanitic deadened sound. Slight dulness is, as a rule, noted first below the clavicle, though in not a few cases it is first detected above the clavicle when there is retraction of the apex. Impaired resonance, however, may be detected first in the supraspinous fossa, and less frequently in the interscapular space if the subject is not too stout, though slight dulness in the absence of other signs has little diagnostic value. The corresponding regions of the two sides must be compared during a held inspiration and also during a held expiration. The degree of dulness can sometimes be better estimated by comparing the apical note with that obtained lower down on the same side, allowing for the normal topographic differences of intensity. The latter method is especially applicable to cases in which both apices are involved. Light and single percussion blows must be used. As the lung tissue becomes airless throughout an area of considerable size the note is deadened until dulness is heard; finally, with extensive consolidation, the note may be wooden and the feeling of resistance increased.

Auscultation.—Emphasis should be placed on the importance of auscultation in the diagnosis of early tuberculous infiltration. As pointed out by Schneider¹ and generally recognized by most workers in tuberculosis, the first physical apex signs are to be detected by auscultation only. The vesicular breathing may be sharpened, with prolongation of expiration, owing to narrowing of the smaller bronchi, but more often perhaps it is diminished by the swelling and secretion. The corresponding regions on the two sides must be compared—first during quiet, and then deep breathing—and it should be remembered that prolonged expiration is an early and important diagnostic sign, at first being somewhat sharpened, and later distinctly bronchial. The breath sounds may at times be irregular, jerky, or wavy, chiefly during the inspiratory phase. Such a type of vesicular murmur may be due to forced inspirations and has a diagnostic significance only when sharply localized. Tuberculous bronchitis may cause interrupted or jerking inspiration at the apex with or without crepitant râles. If heard elsewhere, it has small value. With lobular consolidation at different points in the region affected, the conditions favor the transmission of the bronchial sounds, but these are toned down by the remaining intact air-cells; hence there is "transition" or bronchovesicular breathing. With complete consolidation pure bronchial breathing is audible,

¹ *Deutsch. med. Wchnschr.*, August, 1915.

the fluid contents of the latter are thus brought into contact with the chest wall; this, although an almost certain sign of a cavity when present, is exceedingly rare. The so-called cracked-pot sound is often elicited over large parietal cavities with thin walls; but, since it also occurs in many other pathologic conditions, its diagnostic significance is subordinate. There may even be normal resonance if the cavity is covered by a layer of unaffected air-cells of considerable thickness.

Auscultation over small vomices with lax walls reveals *cavernous* (low-pitched) breathing, while over large cavities with tense walls (if parietal and communicating with a tracheobronchial column of air) it gives amphoric (high-pitched) respiration. Moist râles (bubbling, gurgling, according to the consistency of the secretion) may be present, and these correspond in the main to the amphoric breathing, hence being heard most frequently over large, smooth-walled and peripherally located cavities. The gurgling and slushing sounds caused by the air bubbling through the secretion in a cavity are intensified by coughing.

The *sounds of falling drops* (metallic tinkling) may be heard over large vomices with tense, smooth walls containing thin secretion. *Pectoriloquy* and *amphoric whispers* are the vocal sounds heard over huge cavities. Whispering pectoriloquy was present in 55 out of 58 cases at the Phipps Institute, but other pathologic conditions may cause this sign, "notably consolidation about a bronchus" (Landis).

Fig. 22.—1. Small cavity near periphery, with thick relaxed walls, containing secretion and communicating with a bronchus (vide subjoined table). 2. Large parietal cavity, with thin, tense, smooth walls, communicating with a bronchus (vide table).

PHYSICAL SIGNS

- (a) Percussion deadness on a strong blow, mere impairment of resonance on a light blow; Wintrich's interrupted change of sound, detectable only when patient is upright.
- (b) On auscultation low-pitched cavernous (hollow) breathing; gurgling râles.
- (c) Pectoriloquy indistinct, owing to small size of cavity and the contained fluid.

PHYSICAL SIGNS

- (a) Amphoric percussion-resonance, cracked-pot sound, and Wintrich's change of sound.
- (b) On auscultation, high-pitched amphoric (musical) respiration and metallic râles.
- (c) Amphoric (musical) voice and amphoric whisper.

GENERAL SYMPTOMS.—(a) *Fever.*—While the disease is progressing fever is a constant, significant, and, it may be, the earliest symptom. If a two-hour record be kept for a few days, from time to time an accurate conception

of the course and type of the fever can be formed. In the first and middle stages the highest temperature occurs about 4 or 5 P. M., the lowest about 4 or 5 A. M. The fever may be continuous, remitting, or intermitting, and in a general way these types, in the order named, correspond to the stages of tuberculization, softening, and cavity formation. Modified types, due to the fact that the lesions may simultaneously represent different stages, are also observed. Apyrexial periods are met with in the early as well as the late stages of chronic phthisis, and indicate cessation of the processes of tuberculization and caseation.

A *continued fever* is most apt to be met with during the initial period, the evening temperature sometimes registering but a degree higher than the morning. A similar curve may be presented at any later time if acute pneumonia supervene, though it is to be recollected that the remissions in such cases are usually greater than in primary lobar pneumonia.

A *remittent fever* is more common than the preceding type. It may be present from the start, but is oftener seen in the middle and less frequently in the advanced stages. It points to softening (Fig. 23).

An *intermittent fever* is also frequent, and is invariably associated with cavity formation. The temperature may be intermittent from the start, suggesting malaria to the unguarded; but it is due to sepsis, the temperature rising during the day, beginning usually shortly before noon, and reaching its maximum at from 5 to 8 P. M. It now falls slowly until about 4 or 5 A. M., and then rapidly reaches the minimum—a subnormal point—usually at from 6 to 10 A. M. For a considerable portion of every twenty-four hours the temperature may be below the normal (Fig. 24), sometimes dropping as low as 95° F. (35° C.). A marked peculiarity of this disease is the striking contrast between the apparent comfort of the patient and the temperature record.

Fig. 23.—Temperature-chart of a case of phthisis. Quiescent cavity in right apex, and commencing excavation in left apex. Robert G—, aged twenty-one years; dyer.

(b) *Night-sweats* occur in a large majority of cases. They may appear during any part of the course of phthisis, though most apt to occur and be most marked during the process of cavity formation; they show themselves in the early morning hours simultaneously with the rapid decline in the temperature,

and may appear during sleep at any period of the day. They may be light and limited to the neck and upper portion of the thorax; on the other hand, they are often excessive, saturating the bed-clothes and inducing great exhaustion. The drenching sweats are dependent partly upon the fever and partly upon the existing weakness, though slight exertion may also engender free perspiration.

(c) **Emaciation** occupies a prominent place in the symptomatology, the muscular and fatty tissues being involved to an equal degree (Strümpell); the extremities and soft parts of the thorax are most affected. An exalted grade of emaciation, however, may be a precursory state. In nearly all cases an extreme degree of emaciation is reached before the end. The causes of emaciation are chiefly the persistent fever, the loss of appetite, and the feeble digestive and assimilative powers. It is an almost invariable rule that during the afebrile periods, associated as they are with improved appetite and digestion, the patient gains in flesh and strength. Unilateral atrophy of the muscles of the chest may be observed.

(d) The **pulse** is increased in frequency, is of good volume, and regular in rhythm. When suppurative fever sets in it becomes frequent and compressible, and the capillary pulse is often observed; rarely venous pulsation is seen in the hands. The *blood-pressure* is always reduced in uncomplicated cases, so that a systolic pressure under 100 mm. in a suspected case of tuberculosis is a strong confirmatory finding. According to Norris the toxic hypotension of tuberculosis may be due to: (1) weakness of the heart muscle, either as a result of the toxins or of malnutrition; (2) vasodilatation the result of tuberculous toxins; (3) nervous influences the result of the toxemia, with consequent tachycardia and vascular dilatation.

Fig. 24.—Temperature-chart of a case of phthisis. Cavity in left apex, giving cracked-pot sound, Wintrich's sign, etc. George C—, aged twenty-two years; glass-worker.

(e) **Anemia** is one of the symptoms evidencing impaired nutrition. It is often associated with an afternoon rise of temperature, impaired digestion, and loss of flesh and strength (chloro-anemia). The objective changes pointing to anemia are pronounced (pallor of visible mucous membranes, and skin).

The *blood* presents nothing characteristic. In the early stage it may be chlorotic in type, the hemoglobin being decidedly deficient; but when there are cavity formation and hectic fever, considerable leukocytosis, as many as 50,000 leukocytes per cubic millimeter, may be observed. The differential count shows a great excess of the polymorphonuclear cells. The condition is due to secondary infection by the pus-forming organisms. Early lymphocytosis, however, may be of considerable diagnostic value. It is certainly of good prognostic portent, as the work of Murphy, at the Rockefeller Hospital, has shown. Barlaro holds that tuberculous toxins may induce an increase in the number of red corpuscles with or without enlargement of the spleen. Polycythemia may alternate with anemia, but the former gives a better prognosis. Tubercle bacilli cannot, as a rule, be found in the circulating blood (Ravenel and Smith).

General debility is complained of in all cases, and is progressive.

SYMPTOMS AND COMPLICATIONS PRESENTED BY OTHER ORGANS.—(a) The Heart.—With retraction of the upper lobe of the left lung the area of the heart's impulse is obviously increased, particularly upward, so that pulsation may be visible in the fourth, third, and even second interspaces, near the sternum, while the normal apex-beat may be wanting. The physical signs noted may be rarely those of displacement of the heart to the right, while the necropsy may show the heart to be in its normal position. Functional murmurs both at the apex and at the pulmonary orifices are often audible. In about 7 per cent. of the cases with murmurs, mitral regurgitation, dependent on weakness of the heart muscles, was diagnosticated. Disease of the tricuspid segments is not infrequent in phthisis, and pulmonary stenosis predisposes to the latter disease. Conversely, there is perfect agreement among writers that left-sided valvular heart disease has a retarding influence upon the progress of chronic phthisis. In cases in which the valve lesions and the compensatory hypertrophy are proportional, a prognosis for an unusual length of days can be ventured, but "when this harmonious balance is disturbed an early fatal termination may be expected, principally from the cardiac complaints" (Montgomery¹). In combined cases dyspnea is more pronounced and hemoptysis a more common initial symptom than in non-cardiac forms.

(b) Gastro-intestinal Tract.—The *tongue* may be furred; more often it and the mouth and throat are red, showing increased irritability. The *pharynx* may be the seat of tuberculous lesions, which may interfere with deglutition. *Aphthous ulcers* and *thrush* may also arise. The appetite is impaired or lost; thirst is annoying and the symptoms of chronic gastritis often obtain. A catarrhal ulceration and dilatation may be associated conditions. Vomiting may be troublesome during the later stages. A study of the gastric secretion gives variable results, there being an early hyperacidity, while later the secretion is subacid. Mohler and Funk² claim that there is no early "irritative stage" giving hyperacidity, but that pulmonary tuberculosis causes a definite downward progression in both the motility and the secretory function of the stomach from the very beginning of the disease. Croner found normal motility present in the early stages. The *causes* of gastric symptoms are not clear. The mucosa is the seat of venous engorgement, and thus occasions the catarrhal changes that are present in many instances. Anatomic changes may be absent.

The *intestinal symptoms* are important. During the early stage constipation is a frequent condition. Diarrhea is prone to appear at an advanced period, and may pursue an intermittent course. Occasionally it alternates with periods

¹ *Amer. Jour. Med. Sci.*, June, 1910.

² *Ibid.*, September, 1916, clii, 355.

[“hectic fever,” and late in the affection a watery discharge may develop (*colliquative diarrhea*). The intestinal lesions are of three sorts: (a) *catarrhal*, (b) *ulcerative*, and (c) *amyloid*. These often arise in the order enumerated, but may be combined in various ways. Hemorrhoids and anal fistulæ are among the complications.

(c) **Genito-urinary Organs.**—There is frequently an albuminuria that may either be febrile or due to chronic nephritis (*productive* and *non-productive*). *Chronic nephritis* is usually a late development; it gives rise to albuminuria, tube-casts in the urine, and dropsy. The total nitrogen excretion is lower than the normal. *Amyloid changes* may set in toward the close, with their characteristic symptoms. Tuberculous *pyelitis* and *cystitis*, with the appearance of pus and blood in the urine, may develop. Hematuria may also result from temporary congestion. The testes should be routinely inspected (Osler).

(d) **Cutaneous System.**—*Cyanosis* occurs, but, being of a moderate degree, it is often veiled by a decided pallor. The *cheeks* often wear a “hectic flush,” and the skin, late in the affection, is apt to be dry, harsh, and scaly. Among the cutaneous appearances are pigmentary stains over the chest (*chloasmata phthisicora*) and brown stains (*pityriasis versicolor*). Rarely, simple purpura and purpura hemorrhagica develop as late complications. The *hair* over the chest often becomes gray; that of the head and beard, long and harsh. The *finger ends* are often bulbous (clubbed), with incurved nails, though this is not peculiar to chronic phthisis, and cracking of the finger-nails is also often observed.

(e) **Nervous System.**—The mental attitude is characteristically hopeful and buoyant, even in the advanced stages. Hence the patients are readily encouraged by the unscrupulous to believe that their condition is improving; they may be in an utterly helpless state, and yet confidently expect to recover. The *cerebral symptoms* are rarely marked, and the mind is exceptionally clear. Tuberculous meningitis and meningo-encephalitis may develop near the close. Focal lesions, due to the presence of tubercles, may produce forms of paralysis (aphasia, hemiplegia) according to their location. Rarely peripheral neuritis (*e. g.*, extensor paralysis of the leg) and insanity are observed. There may be early unilateral dilatation of the pupil, with sluggish reaction to light, due to enlargement of the bronchial lymph-nodes on the corresponding side.

(f) **CHEST MUSCLES AND MAMMARY GLANDS.**—The former are abnormally irritable, and sometimes even painful on percussion, and the mammary gland is in rare instances hypertrophied, males suffering most; but, as pointed out by Allot, the affection is a chronic non-tuberculous mammitis.

Diagnosis.—The early recognition of chronic pulmonary tuberculosis often tests severely the diagnostic acumen of the physician. The general and local symptoms, including the physical signs, may afford merely a strong suspicion of the existence of phthisis, and in such instances repeated examinations of the sputum for the bacilli are imperative, and only when they are found is the diagnosis set at rest. Repeated staining of the sputum may be necessary for the detection of tubercle bacilli. It is also desirable to determine whether they are constantly present by re-examinations at intervals. There are cases in which the physical signs are obvious, yet the bacilli are either not detectable or only so after several examinations. An absence of the bacilli, however, does not justify a denial of the existence of phthisis, and is of little negative value. Philip and Porter conclude that tubercle bacilli are almost constantly present in the stools, whether the patient be expectorating bacilli or not. The symptoms of greatest diagnostic value are cough, expectoration, fever, progressive emaciation, and the constant presence of certain physical

signs in the subapical region on one side (flattening of the chest, defective expansion, slight deadening of the percussion-note, enfeeblement of the vesicular murmur, prolonged expiration, with or without adventitious sounds). Roentgenograms that show the presence of tuberculous deposits and pleuritic exudates may, at times, give the earliest positive information in regard to these conditions. Again, more reliable knowledge can be gained in the initial stage, if the lesions be deep seated, by the fluoroscope than by practising the physical signs. Thus enlarged bronchial glands and peribronchial infiltration are detectable, as well as variations in the position and movements of the diaphragm.

On the other hand, Roentgen findings fail to distinguish between an active and a healed tuberculous lesion. Neither can the roentgenologist exclude the lung shadows due to pathologic states other than tuberculosis. Manges points out that stereoroentgenograms of excellent quality are essential to negative diagnosis in any portion of the lungs.

The *tuberculin test* is warmly commended by Trudeau, Otis, Klebs, and others. It is fairly accurate, and out of a total of 1470 injections in dubious cases, 71.9 per cent. reacted positively. The employment of tuberculin is indicated only when the usual methods of diagnosis fail, as it has at times either caused a lighting up of what was apparently previously a latent infection or given rise to a marked increase of symptoms in an active case. Koch's old tuberculin is the best variety for diagnostic purposes. A preliminary injection of 0.0005 c.c. should be administered. If no reaction takes place, successive injections of, 0.001, 0.005, and 0.01 c.c. may be given three or four days apart. It is advisable to repeat each dose. Special hypodermics graduated in 0.001 c.c. are used to give the injection, which is made subcutaneously. The patient should be kept quiet following the injection and the temperature should be taken every two hours while awake, with the thermometer in the mouth for at least four minutes. A typical reaction occurs in twelve to twenty-four hours after injection. It is manifested by a general feeling of malaise, rise in temperature to about 101° F. (38.3° C.), or a little less than 110° F. (37.7° C.), or even much higher, changes in physical signs in chest at times, and changes in other tuberculous areas. A rise in temperature of at least 1.8 degrees is considered essential to a reaction. Temperatures of 100° F. (37.7° C.) or more during the day are a distinct contraindication to the injection. The positive reaction is of value only when the questionable symptoms and physical signs of tuberculosis are exaggerated by the injection. Positive reactions are said to occur in syphilis, chlorosis, actinomycosis, and hysteria. Except in leprosy this statement has not been verified by autopsy, which showed in such cases an absence of tuberculosis.

Calmette's ophthalmic reaction, which consists in dropping 1 to 2 minims of a 0.5 to 1 per cent. solution of tuberculin into the eye, produces hyperemia of the conjunctiva (at times actual conjunctivitis) in from three or four to twenty-four hours without constitutional disturbance. The method is not to be recommended, however, on account of the serious ocular complications that occasionally may arise. The symptoms subside in from twenty-four to forty-eight hours. Von Pirquet applies the tuberculin (25 per cent. solution of old tuberculin) with gentle friction to the slightly scarified skin. If the patient be tuberculous, a reaction manifested by a papule surrounded by a distinct erythema at least 4 mm. in diameter occurs in from six to forty hours; this is especially valuable in the diagnosis of tuberculosis among children. In inactive tuberculosis the response to a repetition of skin test is more pronounced than at the first test, while the reverse is true with active tuberculosis (Lindberg). In adults, however, other signs of tuberculosis must be present

to render it of any diagnostic worth, since latent or healed foci may produce the reaction, though the erythematous papule usually appears after thirty-six hours, while in active tuberculosis it appears within a few hours after the application of the tuberculin. However, as Krumbhaar and Musser¹ have pointed out, the test has great negative value and, contrary to prevailing opinion, much positive value. Bass² made 1165 tests on 206 children and found that if but a single von Pirquet test had been employed, a positive reaction would have shown by only 3.3 per cent.; if two tests had been used, the percentage would have been doubled (6.8), while by the subsequent use of the intradermic tests the true percentage of cases was found to be 25.2. The Moro reaction is somewhat less delicate, and for that reason is preferred by some. Old tuberculin incorporated in a lanolin base is rubbed vigorously into the skin in a small space for two minutes. A positive reaction is shown by the appearance of a small papular rash within seventy-two hours. The opsonin test is useful in the diagnosis of early tuberculosis, the index to the tubercle bacillus being very low or very high, the former suggesting predisposition, the latter showing infection against which the resisting powers are raised in defense (J. C. DaCosta).

The complement-fixing reaction can be used with advantage in diagnosis.³ Craig⁴ claims that the results obtained with the complement-fixation test as described by him are practically as good as those obtained with the Wassermann test for syphilis. Unlike the tuberculin test, this is, as a rule, negative in arrested cases, while almost uniformly positive in active tuberculosis. Moon⁵ is also very positive in his statement that the reaction is well past the experimental stage, and should be regarded in the same manner as the Wassermann test in syphilis. In spite of the enthusiasm of these and other serologists and phthisiographers there are expressed too many inexplicable converse opinions, well backed up by efficient, well-controlled laboratory experimental and clinical work, to accept without further study the specificity of the test. It would seem that the wisest position to take would be a middle one, and that the safest course would be to consider a positive reaction merely as a finding of value when taken into consideration with other symptoms, objective and subjective. Since writing this paragraph an article sustaining these views by Pritchard and Roderick⁶ has appeared upon the value of this test. These authors' views seem so thoroughly rational and conversative that they will be quoted in part: "The test is of value and should be included in the routine examination, but should not be relied upon without additional and confirmatory evidence. . . . Any test which adds to our information, although not conclusive in itself, should be used as a link in the chain of evidence." Brown and Petroff⁷ believe that the test is of particular value as a negative one.

In the very early stage the local condition may be obscured by the symptoms of impaired digestion, loss of flesh and strength, fever, and pronounced anemia (chloro-anemia, *vide* p. 261; also *Modes of Onset*). A slight inexplicable rise of the evening temperature (99.6° F.—37.5° C. or over) is, if associated with any disturbance of health, an almost infallible diagnostic symptom. In the more advanced stages of phthisis the diagnosis is rarely difficult.

Diagnosis of Stage of Disease.—Three stages of tuberculosis are recognized—incipient, moderately advanced, and far advanced. The following scheme of

¹ *Amer. Jour. Med. Sci.*, 1914, cxlvii, 540.

² *Amer. Jour. Dis. Child.*, May, 1918, p. 313.

³ *Jour. Amer. Med. Assoc.*, October 9, 1915, p. 1286.

⁴ *Amer. Jour. Med. Sci.*, December, 1915, p. 781.

⁵ *Jour. Amer. Med. Assoc.*, 1918, lxxi, 1129.

⁶ *Ibid.*, 1919, lxxiii, 1879.

⁷ *Amer. Rev. Tuberc.*, 1918, ii, 525.

classification is recommended by the National Association for the Study and Prevention of Tuberculosis:

Incipient (favorable)	{ Slight initial lesion in the form of infiltration limited to the apex or a small part of the lobe. No tuberculous complication. Slight or no constitutional symptoms (particularly disturbances or rapid loss of weight). Slight or no elevation of temperature or acceleration of pulse at any time during the twenty-four hours, especially after rest. Expectoration usually small in amount or absent. Tubercle bacilli may be present or absent.
Moderately advanced	{ No marked impairment of function either local or constitutional. Localized consolidation moderate in extent with little or no evidence of destruction of tissue. Or disseminated fibroid deposits. No serious complications.
Far advanced	{ Marked impairment of function, local and constitutional. Localized consolidation intense. Or disseminated areas of softening. Or serious complications.

DIFFERENTIAL DIAGNOSIS.—*Bronchial catarrh* is with great difficulty discriminated from beginning phthisis. If the temperature is elevated from 2 to 5 P. M., and not at all or only slightly above the normal night temperature in the evening, the probabilities are greatly in favor of tuberculosis (Barlow). In bronchial catarrh there is no dulness, and moist râles, that vary in intensity from one day to another, are heard equally on both sides. From time to time râles may also be heard at the bases in bronchitis. In phthisis one apex is more involved than the other, the moist sounds not being heard equally low, and after repeated coughs with subsequent deep inspiration the râles are more apt to remain than in ordinary bronchitis. In phthisis, also, there is a gradual loss of flesh and strength, and repeated microscopic examination of the sputum will demonstrate the presence of the bacillus. A negative reaction, obtained repeatedly from the Falk and Tedesko test, is evidence that the disease process is limited to the bronchi, while a positive reaction indicates pulmonary involvement (tuberculosis). According to Armstrong and Goodman,¹ however, this test is unreliable. If *hemoptysis* be the first symptom observed, then all other causes for the spitting of blood should be patiently excluded, unless the associated evidences of commencing phthisis are conclusive. Phthisis in the stage of cavity may be confounded with *bronchiectasis* (*vide* Diseases of the lungs).

Mycosis and Spirochetosis.—Unquestionably many cases of mycosis have been labeled pulmonary tuberculosis without proper study of the sputum. The same remark may be applied to the more recently described spirochetal infections of the bronchi and lungs. Both conditions may closely simulate tuberculosis and may at times only be differentiated by careful cultural and morphologic study of the sputum.

¹ *Jour. Amer. Med. Assoc.*, May 27, 1911, p. 1553.

FIBROID PHTHISIS

Definition.—Fibroid phthisis implies induration followed by contraction of the affected lung tissue, due to an increase in the connective-tissue elements. There are cases in which it cannot be distinguished pathologically from chronic pulmonary phthisis, but they differ clinically. The majority of instances are primarily tuberculous, though manifesting a strong tendency to the formation of fibrous tissue—a conservative process; in other instances the fibroid change may be primary, followed by tuberculous infection (*vide* Pneumonokoniosis). The usual form arises variously as a sequel of other morbid processes, such as—

- (1) Pneumonias, lobar (rarely) and catarrhal (commonly).
- (2) Pulmonary lesions—tubercle in the stage of consolidation or cavity.
- (3) Chronic tuberculous pleurisy.
- (4) Bronchial catarrh from inhalation of irritants (steel-, coal-, or mineral-dust).

Pathology.—The process in the beginning is very often localized in one apex, and less frequently in the middle portion of the lung or in the bases. It may remain circumscribed, but more often it extends downward, and gradually invades the entire lung. It is unilateral. Secondary to the induration and contraction there is dilatation of the bronchi.

The lung tissue is hard and dense, the alveoli being obliterated. It resists cutting and creaks, and the section presents a smooth, dry, gray, often marbled aspect, though the fibrous tissue may undergo caseation.

The pleura is thickened, as a rule, often to a marked degree, and its layers are adherent; the unaffected portions of the lungs frequently become emphysematous. The right ventricle is, as a rule, hypertrophied.

Symptoms.—These may be briefly stated, since they do not differ from those of cirrhosis of the lung (*vide* Diseases of the Lungs). The *onset* is insidious: a persistent *cough*, occurring in severe paroxysms in the mornings, and a *purulent expectoration* are for long the leading features. If bronchiectasis is present, the sputum may be fetid. *Dyspnea* is marked, particularly on exertion. *Fever* is slight or absent, hence emaciation progresses slowly or may even be absent. The *physical signs* are identical with those of fibroid induration of the lung (*vide infra*).

The **course** of this disease is long, ranging from ten to twenty or even thirty years, and both lungs may become involved. Again, as in chronic pulmonary tuberculosis, prolonged suppuration may lead to amyloid changes in the liver, spleen, kidneys, and intestines. *Dropsy*, due to secondary dilatation of the right ventricle, often closes the scene.

Differential Diagnosis.—*Chronic bronchitis* may be mistaken for fibroid phthisis. In the latter disease, however, there are unilateral retraction and the signs of consolidation or of an apical cavity, and the sputum test may settle the doubt.

Complications of Pulmonary Tuberculosis.—*Lobar pneumonia* and, less commonly, *lobular pneumonia* may develop and cause a fatal termination. In a study of 100 cases H. M. King found the principal complications of a non-tuberculous character were lobar pneumonia and nephritis.

Erysipelas may arise in the course of chronic pulmonary tuberculosis, though the proportion of cases is not formidable. Out of 1165 cases of erysipelas, 15 coexisted with pulmonary phthisis. Some contend that its occurrence in this disease may be beneficial, but my own observations show that the gravity of both conditions is increased. *Typhoid fever* may rarely be met with in sufferers from chronic phthisis.

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(b) The secondary variety occurs in more than one-half of the cases of pulmonary tuberculosis, the chief seats of the lesions being the lower part of the ileum, the cecum, and the upper part of the colon. The rectum is also the seat of secondary tuberculosis in a small proportion of the cases of chronic phthisis, and it may be rarely a primary seat of the affection.

The morbid process begins in the solitary glands in Peyer's patches, where at first grayish, firm tubercles grow and form little prominences. These caseate, becoming yellow in appearance, and then soften and disintegrate, producing ulcers. Osler thus describes the characteristics of the tuberculous ulcer: "(a) It is irregular, rarely ovoid or in the long axis, more frequently girdling the bowel; (b) the edges and base are infiltrated, often caseous; (c) the submucosa and muscularis are usually involved; and (d) on the serosa may be seen colonies of young tubercles or a well-marked tuberculous lymphangitis." In all *acute* cases the surface lesions show little tendency to repair (Senn).

In *chronic* cases attempts at healing are the rule; and the cicatrices are extensive and often pigmented, and as they undergo contraction may produce incomplete or even complete stricture of the bowel. At a point corresponding to the seat of the ulcers local peritonitis invariably develops. The serosa is thickened and adherent, and the ulcer may penetrate through this coat without causing perforative peritonitis, while rarely a fistulous connection is established between the different parts of the intestine.

Symptoms.—In children the symptoms are those of a protracted catarrh of the intestines, or they may be absent. Among prominent features are diarrhea, colicky pains, and the presence in the stools of pus, blood, and particles of mucus resembling sago grains. In many cases there is constipation, which may be due either to peritonitis or cicatricial stenosis. The general symptoms are irregular fever, wasting, and a lack of development; they are especially valuable for diagnosis.

In adults intestinal tuberculosis generally gives rise to symptoms similar to the above, and when they arise in the course of pulmonary phthisis they are highly significant. If diarrhea be present, it stubbornly resists treatment, and it must not be forgotten that it may also be due either to catarrhal colitis or to amyloid change, both of which processes may be associated with chronic phthisis. Constipation is common and often marked, and local tenderness and colicky pains are complained of frequently. The pulmonary signs, however, may be in abeyance.

If the abdominal and general symptoms are such as to excite suspicion of this disease, then a rigid physical examination of the lungs should be made. The chief seat of the lesions may be for a long time in the cecum or in the appendix, when the symptoms—both local and general—will be those of appendicitis. Gray states that intestinal perforation, usually occurring in the ileum, is not uncommon as a cause of death.

The *diagnosis* of primary intestinal tuberculosis is beset with special difficulties. Sawyer has in special instances demonstrated the presence of clusters of tubercle bacilli in the rectal mucus, and in this way the recognition of intestinal tuberculosis at an early date, or before diarrhea sets in, is rendered possible. The mucus is obtained after placing the patient in a position as if to examine for piles, and directing him to bear down as though at stool, by gently removing a small quantity from the everted membrane with a sterile loop. It is then spread upon a clean cover-glass and treated exactly as sputum in the ordinary examination. The same method is applicable to cases of secondary intestinal tuberculosis, but here the history and associated tuberculous lesions usually serve to remove all doubt. By the use of an antiformin process the finding of tubercle bacilli in the stools has become comparatively easy and certain.

TUBERCULOSIS OF THE ALIMENTARY TRACT

(1) **Lips.**—While tuberculosis of the lip is quite rare, the possibility of its occurrence must not be forgotten. It assumes the form of a small ulcer, and the diagnosis is made by an examination of the labial mucus. It is usually associated with laryngeal or pulmonary tuberculosis. In *diagnosing* the condition, chancre and epithelioma must be excluded, the former by the history and the Wassermann reaction, and the latter chiefly by a microscopic examination for tubercle bacilli.

(2) **Tongue, Palate, and Tonsil.**—The work of Orth, Hanan, Schlenker, Kruckman, and others has shown that the tonsils, owing to their frequent inflammation, serve as the door of entrance of the tubercle bacilli. The fact that tuberculosis of the tonsils has repeatedly been found, and when other lesions of the disease were absent, points to the not infrequent occurrence of primary tuberculosis in this site. The infiltrated areas often present small grayish spots, but the appearance of the ulcers is not characteristic, frequently bearing a strong resemblance to epithelioma and to the syphilitic ulcer. E. D. Smith records 5 cases of tuberculosis of the soft palate. According to Scott,¹ tuberculosis of the tongue, especially between the ages of forty and fifty years, is of more frequent occurrence than is commonly supposed. The *diagnosis* demands either inoculative experiments or a microscopic examination of the oral mucus. Syphilis can be excluded by a negative Wassermann reaction.

(3) **Pharynx and Esophagus.**—Both miliary tubercles and ulcerative lesions may rarely arise on the posterior wall of the pharynx by direct extension from laryngopulmonary tuberculosis or as the result of secondary inoculation. The chief symptoms occasioned are the excessive secretion of pharyngeal mucus and mucopus, and painful deglutition. Tuberculosis of the esophagus is extremely rare.

(4) **The Stomach.**—Tuberculous lesions of the stomach are of exceptional occurrence. Marked gastric symptoms, however, are common, and they may be due to involvement of the larynx. I have been able to find reports of 5 cases of tuberculous gastric ulcer in addition to the 12 collected by Marfan. According to Broders, in addition to ulcer, other types may be met, *e. g.*, miliary tubercle, solitary tubercle, pyloric stenosis, tumor or nodule, and lymphangitis. The ulcers may be single (as in Musser's and Lamb's cases) or multiple (as in Osler's case). In a series of 2501 gastric operations at the Mayo Clinic, tuberculosis was found only once. The *symptoms* are not characteristic, but hematemesis occurring in patients suffering from tuberculosis of other organs should excite a strong suspicion of the existence of ulcer. Pain coming on soon after mealtime is more marked in tuberculous ulcer than in ordinary gastric lesions. Perforation may take place. Four cases are recorded in which the pylorus was found encircled with a flat, granular ulceration, operated on under the diagnosis of carcinoma (Alexander). The process was isolated and the symptoms all pointed to pyloric cancer.

(5) **Intestines.**—The lesions may be (a) primary or (b) secondary.

(a) Primary tubercle of the intestines is chiefly met with in children, for the reason that they are more likely to swallow the tubercle bacilli with their food, and especially in milk. The intestinal route of infection is, according to my own observation, more common in adults also than is supposed. Many cases during life present the features of both intestinal and peritoneal tuberculosis, and it is often impossible to determine which of these was the primary condition; and the same difficulty arises when the cases come to autopsy. I have never seen an instance (postmortem) of intestinal tuberculosis in which the peritoneum and mesenteric glands were not involved to an equal degree.

¹ *Amer. Jour. Med. Sci.*, September, 1916, p. 411.

evidences of pulmonary tuberculosis are of diagnostic importance, or the super-vention of acute general miliary tuberculosis makes clear the nature of the case. The *subacute variety* with effusion may terminate, after absorption of the exudate, in chronic adhesive pleurisy with great thickening of the membrane. The latter may also originate as a primary proliferative process.

(c) TUBERCULOSIS OF THE PERICARDIUM

The morbid lesions are analogous to those of tuberculosis of the pleura. The effusion may be enormous on the one hand or insignificant on the other, and it is often hemorrhagic, while in the chronic form there is marked thickening of the membrane with the deposit of tubercles and cheesy masses. The affection is less common than tuberculosis of the pleura, yet not so rare as was formerly supposed, and occurs in the acute and chronic forms.

Acute tuberculous pericarditis is rarely a primary affection, and, as a rule, originates secondarily to pulmonary, pleural, or glandular tuberculosis. It is especially prone to arise in tuberculosis of the bronchial and mediastinal lymph-glands, and, as the latter condition is frequent in young children, so tuberculosis of the pericardium is relatively frequent at this period, though it may occur at any time of life. Pericardial tuberculosis also results from direct extension from a contiguous focus. The symptoms will be detailed in the discussion of Pericarditis. In the *diagnosis* of the affection the history and any associated tuberculous processes detectable must be taken into account, and a point of some diagnostic value rests in the fact that tuberculous pericarditis does not show the usual inflammatory leukocytosis.

Chronic Tuberculous Pericarditis.—This may be a part of the general tuberculosis of the serous membranes, or it may follow an infection of the bronchial and mediastinal glands (most frequently), lungs, pleura, or peritoneum. Cases of primary origin also occur, but they are exceedingly rare, the neighboring lymph-glands being generally involved. This form is also dependent upon direct extension from the spine and sternum.

From personal observation I am convinced that the cases naturally fall under two heads when considered clinically: those without effusion, in which the pericardium is adherent; and those with more or less effusion. The former are the more frequent, though often entirely latent, the adherent pericardium leading to hypertrophy of the heart, followed sooner or later by dilatation. The signs are, therefore, those of adherent pericardium, with the occasional difference that the dulness may extend higher up over the sternum, in consequence of the presence of firm, cheesy masses at the base of the heart and also encircling the aorta. The smaller group of cases (in which the effusion is present) resembles dilatation of the heart in its clinical manifestations. I recall one instance of this sort that occurred in a male aged about sixty years at the Episcopal Hospital, the autopsy revealing extensive pulmonary tuberculosis and chronic tuberculous pericarditis, with the presence of 8 ounces (240.0 c.c.) of hemorrhagic effusion.

TUBERCULOSIS OF THE SEROUS MEMBRANES

General tuberculosis of the serous membranes *secondary* to pulmonary and intestinal tuberculosis is of common occurrence, and that a *primary* form of tuberculosis of the serous membranes also occurs is undoubted. Unfortunately, accurate means of discriminating the secondary from the primary form are wanting, since often in the secondary variety the primary lesions in other organs are insignificant.

The anatomic alterations resemble those of ordinary inflammation of these structures plus the presence of nodular tubercles. The latter may be observed, as a rule, only over small, scattered, circumscribed areas, though not infrequently they are both numerous and diffuse (general miliary deposit). The effusion is in most instances serofibrinous, though sometimes it becomes purulent, and not uncommonly it is hemorrhagic. Most instances of so-called hemorrhagic pleurisy are due to pleural tuberculosis.

Clinically, cases are divisible into (1) acute serous membranous tuberculosis and (2) the chronic form. The *acute* form results from inoculation of the peritoneum or pleura, induced by limited foci in the bronchial, tracheal, or mediastinal lymph-glands, or in the fallopian tubes in women. The *chronic* type is apt to result from a direct extension of a tuberculous process from some organ adjacent to the pleura or peritoneum, though it may attack the serous membranes primarily. Belonging to this class of diseases are two groups of cases: those attended by serofibrinous or seropurulent effusion and the presence of caseous masses, and those in which there is a tuberculous deposit with increased density and great thickening of the pleural layers, and slight exudation. The pericardium may be similarly involved.

(a) **Tuberculous meningitis** has been described fully in the present section (*vide* Miliary Tuberculosis).

(b) **Tuberculous Pleuritis**.—This subject will be referred to in the section on Diseases of the Pleura. Its import, however, is such that brief special consideration is demanded, and from a clinical viewpoint the cases may be grouped under two heads, namely, *acute* and *chronic tuberculous pleurisy*.

The *acute* form often has a sudden onset, the initial symptoms being a rigor or repeated fits of chilliness, a stitch-like pain in the side affected, shallow, catching breathing, a cough, and fever. The ushering-in symptoms sometimes suggest lobar pneumonia, and a fatal termination is not uncommon, though apparent recovery or a transition into chronic tuberculous pleuritis also occurs.

Chronic tuberculous pleurisy is vastly more common than the acute form, and it is sometimes primary, though more often secondary to pulmonary tuberculosis. In all cases of the latter disease in which the periphery of the lung becomes involved the visceral layer of the pleura is invaded. This leads to plastic pleurisy with adhesion, the membranes containing disseminated tubercles, or to serofibrinous tuberculous pleurisy. As above stated, the effusion may be hemorrhagic and may also become purulent. When the tuberculous pulmonary focus perforates the pleural sac, pyopneumothorax is produced. In tuberculous pleurisy, as opposed to simple pleurisy, there is usually an absence of leukocytosis.

Symptoms.—The *onset* is very insidious and often unnoticed. There may be few symptoms, and yet a physical examination reveals a large serofibrinous exudate. The cough and other symptoms are frequently due to a coexisting tuberculosis of the lungs, and the presence of subcrepitant and dry râles is strongly confirmatory of tuberculous pleurisy. By and by the

umbilical region. *Tympanites*, due to intestinal paresis, is common in cases having an acute onset.

The *acute stage* may be absent, the affection then being marked by slight local and general symptoms (low fever, anemia, slight belly-pains, and a sense of distention). The skin is sometimes pigmented, and usually in patches. There are not a few instances in which the affection is latent, and in one case of this sort with ill-defined general symptoms pigmentation of the skin first directed my attention to the peritoneum.

The **physical signs** of moderate ascites frequently, and those of enlarged mesenteric glands sometimes, are present. These conditions are often combined in children, constituting the so-called *tabes mesenterica*. I cannot conceive of the occurrence of this association of symptoms without simultaneous involvement of the peritoneum, and doubtless co-involvement of the latter membrane and intestines usually occurs. Hamman emphasizes the great frequency with which more than one serous membrane is affected (multiple serositis). The tuberculous new growth in the peritoneum may also form a distinct tumor not unlike that produced by glandular enlargement, while the intestinal coils with their now thickened walls are sometimes knotted together so firmly as to simulate a dense new growth. The exudation may be loculated owing to adhesions between peritoneal layers of the intestinal coils, etc., producing a localized tumor varying in size and position. Such sacculated exudations most frequently occupy the pelvic or umbilical regions, though they may also be found elsewhere in the abdomen. They may be multiple, and are not infrequently too small to be recognized by the physical signs, being often discovered during laparotomy. On the other hand, they may occupy a large portion of the abdomen. An *omental* tumor of characteristic elongated form (produced by a shrinking and curling up of this membrane) is demonstrable, its long axis generally taking a transverse direction just above the umbilicus. Gardiner has observed this tumor to disappear by spontaneous resolution in children.

The *dry, fibrous variety*, which is not infrequent, is often latent, and the condition may be general or localized. It is decidedly more frequent in adults than in children. The *symptoms* are far from characteristic. Among local features are pains, abdominal distention (giving rise to a tympanitic note on percussion), tenderness on pressure, and sometimes a tumor-ridge extending across the upper abdominal region. Among general symptoms are usually anemia and emaciation, with or without fever. Indeed, the temperature may be subnormal, and these cases may show a tendency to spontaneous recovery.

Diagnosis.—Unless tuberculosis of other organs can be demonstrated the diagnosis is often impossible. This is particularly true in cases in which there is no abdominal pain, which is the most important local symptom, nor tenderness. Fever and the presence of a tumor, especially if the latter be elongated and lies transversely in the umbilical region, are important aids; but if tuberculosis of the lungs, pleura, pericardium, appendix, and the tubes, in women, can be excluded, the rectal mucus and the urine should be examined for tubercle bacilli. From the *acute form* several affections must be discriminated:

(a) *Internal Hernia*.—This comes on suddenly; the pain is localized and paroxysmal; stercoraceous vomiting appears in a few hours; the constipation is absolute, and tympanites is marked, but ascites is absent.

(b) Similar symptoms belong to *volvulus* and to the quick incarceration of loops of intestine under bands of adhesions; on comparison they will be seen to differ from those of acute tuberculous peritonitis.

(c) *Enteritis* is discriminated from *acute tuberculous peritonitis* by the pres-

(d) TUBERCULOSIS OF THE PERITONEUM

This is dependent upon infection by means of the bacilli circulating with blood, or upon extension of tuberculous inflammation or ulceration from adjacent organs. In 11 per cent. of 3405 autopsy records Cummins found there was peritoneal involvement. Mention has already been made of the fact that the intestines are often invaded by tuberculosis, and that the serosa is quickly involved in such instances. The condition may rarely be primary. This involvement may remain circumscribed and undergo spontaneous cure if the intestinal lesion cicatrizes, as postmortem findings frequently indicate, but in extensive peritoneal involvement spontaneous resolution is out of the question. These cases may be subdivided into acute and chronic. The *very acute* cases are those forming a part of acute general miliary tuberculosis, or due to perforation into the peritoneal sac from adjacent organs, and Adlebert's classification is as follows: (a) The ascitic form, (b) the ulcerous form, and (c) the fibroid form. Though these groups do not present sharp clinical distinctions, the courses they run vary considerably, as do the results of treatment. In the *ascitic* form the exudate is purulent or seropurulent, and is often encapsulated. In the *ulcerous* the tuberculous new formations, which may be quite large, undergo caseation and ulceration, the latter process being progressive, so that it may perforate the walls of the intestines. This and the ascitic variety may be combined.

In the third or *fibroid* form the peritoneal surfaces are adherent. There is little exudation; the tubercles may be numerous and diffuse, or found only in scattered localized areas. The lesions may represent the concluding stage of acute or subacute tuberculous peritonitis.

Etiology.—Most cases are produced by extension of tuberculous inflammation from adjacent organs, and of 107 cases analyzed by Phillips the lungs were involved in 99, the pleura also in 60, and the bowel in 80. Children are frequent victims to intestinal tuberculosis, and the bacilli often reach the peritoneum through the intestines, as they are also apt to do in adults suffering from chronic phthisis. Extension from the pleura to the peritoneum is frequent (pleuroperitoneal), but from the pericardium is rare. In females the starting point is often the fallopian tubes (Mayo, Murphy), and in either sex it may be the appendix.

Predisposing Factors.—*Age.*—During the period from fifteen to forty years the incidence is most frequent, although it is not uncommon in children under ten years, nor between the fortieth and fiftieth years of life. Subsequently, it rapidly decreases in frequency. In America negroes are more prone than whites.

Sex has a tolerably potent disposing influence. Abdominal surgeons have taught us that the disease occurs more frequently in females than males, owing to the fact that the fallopian tubes are a favorite seat for primary tuberculous infection. The ratio based upon sex is as 3 to 2 in favor of females.

Symptoms.—Some cases develop *abruptly* with *severe symptoms*, as fever, marked constitutional disturbance, rapid small pulse, abdominal pain, vomiting, and sometimes *diarrhea*. The *temperature* may be quite high (103° to 104° F.— 39.4° – 40° C.), or it may be only slightly elevated even in the worst cases. There follow quickly such symptoms as *anemia*, *marked emaciation*, and a pronounced *typhoid condition*. The signs of *peritoneal effusion* (rarely large) are soon in evidence, and are attended sometimes by a suppurative process of temperature, sweats, etc., indicating the presence of *pus* in the peritoneal sac. A few cases are unattended by effusion, and here nodular masses are palpable, while on auscultation friction-sounds may be audible in the

side chiefly affected, though rarely of large size. Renal tumor was palpable in but 20 per cent. of Braasch's cases (*vide supra*). Palpation often detects tenderness, and the outline of the organ may be defined by careful firm pressure with the finger-tips.

Diagnosis.—It is difficult to discriminate *calculous pyelitis*. In the latter, however, the pain is severer, the tumor mass larger, and the hemorrhage more frequent than in tuberculous nephritis. The urine obtained by ureteral catheterization usually shows the presence of bacteria in a non-tuberculous pyelitis, while in renal tuberculosis the urine, if the tubercle bacillus cannot be demonstrated, contains pus which gives no growth after forty-eight hours' incubation on culture-media. The discovery of tubercle bacilli or the demonstration of tuberculosis of the lungs or other organs would remove all doubt. The tuberculin test may be used.

(2) **TUBERCULOSIS OF THE URETER AND BLADDER.**—This is almost always secondary to tuberculous disease of the pelvis of the kidney above, or of the deep urethra, testes, or prostate below. When primary, as rarely happens, the process extends from ureters to bladder. The *symptoms* are those of chronic cystitis, and in all cases in which no other cause for the latter can be found the primary tuberculous lesion must be sought for and the urine carefully examined for bacilli. The smegma bacillus, sometimes present in normal urine, can be distinguished by decolorizing with absolute alcohol, which will take place in about two minutes, while with the tubercle bacillus a very much longer time is required. Others say this is not sufficient, and that only their methods of culture-growth or inoculation will distinguish them. A catheter specimen should be obtained if possible (Ogden). With the development of ulcerative lesions hemorrhage is apt to arise.

(3) **TUBERCULOSIS OF THE VESICULÆ SEMINALES, PROSTATE, AND TESTES.**—The prostate gland and testes are frequently invaded in genito-urinary tuberculosis, and the vesiculæ seminales somewhat less frequently. The morbid process leads to the formation of cheesy nodules, which may, though comparatively rarely, disintegrate, causing excavations or perforation. Rarely the tubercle does not pass through the stage of caseation, but merely shows the presence of numerous embryonic cells.

Etiology.—The condition is usually secondary, but the existence of primary tuberculosis in these organs cannot be denied. Testicular tuberculosis may begin at any period of life, and is of rather frequent occurrence in infants. When it occurs in the latter it is part of a more general tuberculous infection, and is in many instances undoubtedly congenital. In some cases it may be a late hereditary affection.

Symptoms.—In the *testicle*, tuberculosis, as a rule, induces a painless, protracted orchitis, though when cavernous lesions occur the symptoms are more acute. In *prostatic tuberculosis* the bladder is highly irritable, there is great distress felt in the thigh and groin, and micturition is very painful. Catheterization, particularly if the urethra (as is very rarely the case) is the seat of tuberculous ulceration, causes most excruciating suffering, and there may be signs of stricture. *Rectal palpation* detects in the prostate firm nodules varying in size from a pea to a bean, together with enlargement of the organ.

The **diagnosis** of tuberculosis of the prostate is easily made from the vesical symptoms, the presence of tuberculosis in other organs, the result of rectal examination, and the detection of bacilli in the urine. Syphilitic involvement of the testicle is sometimes excluded with difficulty; in the latter disease, however, the surface of the swollen organ presents greater irregularities, and is even less painful than in tuberculosis. The absence of the history of syphilitic infection and the presence of tuberculosis in other organs, particularly in the urogenital system, are valuable points in the discrimination.

TUBERCULOSIS OF THE FALLOPIAN TUBES, OVARIES, AND UTERUS

Tuberculosis of the tubes in women is a not infrequent condition, and may be primary.

Etiology and Pathology.—The tubes, as a result of infiltration are thick, hard, and bound down by false membrane. Their ends are generally closed, but the intervening portion is dilated, and contains mucus, pus, and cheesy material. A catarrhal salpingitis is generally in association. *Uterine tuberculosis* is rare, and its origin is usually attributable to similar involvement of the tubes.

The disease is most common during the period of greatest sexual activity, but young children may suffer (*vide* literature of Hennig), and in them the ovaries and uterus may be implicated without participation of the tubes, as in cases reported by Gusserow. At any period of life the lesions may be microscopic; they usually, however, excite marked local peritonitis, which may become general, with the development of ascites. The process may extend to the vagina.

Diagnosis.—The age, family history, and signs of the tuberculous diathesis must be noted. The disease does not distinguish itself from other tubal tumors by anything characteristic in bimanual palpation. Cases occur with ascites and also without, and in the latter variety plaque-like thickening of the subperitoneal tissue is an aid to diagnosis. The uterine secretions should be examined for bacilli in all obscure cases. Ashton advises an exploratory incision or puncture and examination of the contents of the peritoneum or tubes for bacilli.

TUBERCULOSIS OF THE MAMMARY GLANDS

This is rare; the affected glands present fistulæ and ulcers, with induration of the organ and retraction of the nipple. Warden¹ reports the finding of 58 authentic cases in the literature. Nearly 90 per cent. of the patients were females, and most cases developed in the third decennium. The *symptoms* are sharp and lancinating pains radiating to the arm, and tumor, the latter consisting of one or more nodules. Pyogenic secondary infection, leading to obstinate fistulæ, is common. The axillary glands are often enlarged. A positive *diagnosis* rests crucially upon the finding of the bacilli in the pathologic secretions.

TUBERCULOSIS OF THE BRAIN

Pathology.—Tuberculosis of the brain occurs in two forms, one of which, acute tuberculous meningitis, has been previously described, while the other is a chronic tuberculous infection, usually localized, of the meninges and cortex, and causing meningo-encephalitis. Very rarely the membranes remain intact. The so-called solitary tubercle is an irregularly round mass, varying in size from a small pea to an apple or even larger. It is generally single, though sometimes there are two, and rarely even three, nodules. The tubercle may be embedded in, and be contiguous with, the brain substance, or may be separated from the latter by cysts. The peripheral zone is formed largely of connective tissue, is lighter in color (often translucent), and may contain miliary tubercles, while the central portion, which is cheesy as a rule, may liquefy and thus form a small cavity containing a purulent-looking material. They are seen with greatest frequency in the inferior portions of the brain.

The new growths may compress the longitudinal sinus, inducing thrombosis; they may interfere markedly with the circulation, causing cerebral softening; and, finally, they may excite acute tuberculous meningitis. Tuberculosis of other organs is usually found as an associated condition.

Etiology.—The disease occurs with especial frequency in young subjects, and, according to the statistics of Pribram, in about three-fourths of the cases before the fifteenth year. The symptom-picture is identical with that of brain tumor (*q. v.*).

TUBERCULOSIS OF THE SPINAL CORD

The lesions are those of solitary tubercle of the brain. It is an extremely rare condition, and almost invariably secondary. (For symptoms, *vide* Spinal Tumor and Meningitis.)

TUBERCULOSIS OF THE HEART

(a) *The Myocardium.*—Tuberculous myocarditis, though comparatively rare, is more common than has been supposed. It may be primary, although practically always secondary to a focus in some other tissue, and transmission to the heart generally occurs by way of the lymphatic system. Infection through the agency of the pericardium is also common, and rarely it may be by the blood. Three *pathologic* varieties (here mentioned in the order of relative frequency) are recognized: (a) Large tubercles; (b) miliary variety; and (c) diffuse form, or tubercular infiltration. Generally speaking, the smaller nodules are found usually in the ventricles, and the larger masses in the auricles, chiefly the right. In miliary tuberculosis scattered gray granulations or semitransparent areas are formed. The literature furnishes a total of 72 cases, nearly one-half of which have occurred in persons under fifteen years of age, and is quite rare after the forty-fifth year. The *diagnosis* is difficult and rarely possible. In addition to the suspicious features, such as syncopal attacks of short duration or sudden collapse, with comparative well-being in the intervals, that may be present, the existence of generalized tuberculosis and pericardial tuberculosis, one or both, are essential to a diagnosis. Death may occur suddenly.

(b) *The Endocardium.*—True tuberculous endocarditis is a rare condition. It is most apt to occur in acute miliary tuberculosis. The endocardium is to an unusual degree resistant to the tubercle bacillus. In tuberculous invasion of the mediastinal glands the endocardium may become involved by extension of the morbid process. Infection of the endocardium also takes place through the blood-supply to the heart structure. Vegetations occur on the valves, and in cases in which the lesions are of the ulcerative variety secondary pyogenic infection probably exists. Clinically, the cases of tuberculous endocarditis are extremely difficult of recognition. The history of the case, however, may be of diagnostic significance. "If it can be shown that the cardiac affection developed subsequent to undoubted pulmonary tuberculosis, and if rheumatic and other forms of infectious endocarditis can be eliminated, and especially if there have been neither previous arteriosclerosis nor fibroid degeneration of the viscera, then a reasonably certain diagnosis of tuberculous endocarditis, given the usual signs and symptoms, can be made" (Anders). Of 1232 cases studied by N. G. Seymour, 62, or 5 per cent., were complicated by cardiac disease, of which 25 were cases of mitral incompetency.

TUBERCULOSIS OF THE ARTERIES AND VEINS

This may arise from extension of an adjacent tuberculous process into the vessel, as in chronic phthisis. It causes infiltration of the arterial wall, resulting in thrombosis, or the vascular tubercles may caseate and soften, thus leading to hemorrhage. In tuberculous meningitis the arterial lesions are conspicuous. The perforation of a vein by an old focus is followed by a distribution to all parts of the body of numerous bacilli and the production of acute miliary tuberculosis. Infection of the arteries may also occur through the blood. Of 1778 cases of pulmonary tuberculosis, thrombosis occurred 19 times (H. Ruhl and Hierokles).

General Prognosis.—The prognosis is best reached as in other infectious diseases, namely, by taking into account (a) the severity of the type of the disease; (b) the presence or absence of frequently associated diseases or complications, and (c) the numerous circumstances connected with individual patients.

(a) **The Severity of the Disease.**—Though there are no accurate criteria, we may judge of the severity of the disease by its progress, by the result of proper treatment, and from certain symptoms. If the fever be high, the prostration marked, and the local lesions rapidly advancing we may safely infer that the disease is of aggravated type. With these, certain other considerations are closely connected—the stage of the affection and the extent of the local lesions. Thus at an early stage the prognosis is more hopeful than at a later period, and, similarly, when the lesions are strictly localized at one apex it is more hopeful than when they have reached the stage of extensive cavity formation or are bilateral. As already stated, a certain proportion of the cases manifest an inherent tendency to spontaneous arrest or even cure, and this may occur even after the stage of excavation has supervened. Cavities, however, are a source of danger from metastatic auto-infection. A common error is the mistaking of a temporary for a permanent arrest of the tuberculous process, and in the natural history of the affection the fact was emphasized that its course was interrupted by periods of comparative comfort and noticeable improvement, followed by sharp exacerbations.

(b) **Associated Diseases and Complications.**—These unfavorably modify the prognosis, especially chronic nephritis, gastric complications, or intestinal and laryngeal involvement. Some of the accidents of the disease may precipitate a fatal result (*vide* Modes of Death). The appearance of intercurrent acute pneumonia is indicative of danger. Certain diseases manifest an antagonistic influence, *e. g.*, acute rheumatism, when the disease develops in old luetics, or in the course of left-sided valvular disease of the heart. Murard and Marotte¹ report 3 cases all showing the arrest and tendency to sclerosis of a progressive primary lung process after an intercurrent pleurisy with a moderate effusion left unmolested. Tuberculosis following immediately after or developing during pregnancy is fatal in about 60 to 70 per cent. of cases, according to Baldwin. Other complications have been detailed in the Clinical History.

(c) **Circumstances Connected with Individual Patients.**—(1) A feeble, delicate constitution, either acquired or inherent (tuberculous diathesis), increases the morbidity of tuberculosis.

(2) When the fever subsides and the patient gains flesh and strength, the outlook at once brightens. Maintenance of the weight curve while the patient is in his usual environment is a favorable indication. Konzelmann has observed a number of instances in which a tuberculous process of the lungs

¹ *Paris mèd.*, July 28, 1917, p. 85.

sealed under the influence of a pleural effusion, the theory being that the affected lung is given rest. The temperature and local symptoms often promptly subside. A high polymorphonuclear percentage gives a bad prognosis, while an increasing lymphocyte percentage denotes favorable progress. Cooke¹ affirms that a dislocation of the Arneth count to the left is strong evidence of the existence of an acute tuberculous process. Absence of eosinophil cells would appear to be an unfavorable prognostic sign, while an increase indicates a tendency to arrest the progress of the disease (Swan). Weiss² states that urochromogen in the urine indicates that the defensive powers of the organism are being overwhelmed. The technic is as follows: Into each of two small test-tubes is put 1 c.c. of urine, and 2 c.c. of distilled water are added; now, to one tube which is to be tested for urochromogen, 3 drops of 1 : 1000 solution of potassium permanganate are added, the tube is shaken thoroughly and compared with the control tube. The appearance of the faintest yellow color shows the presence of urochromogen and is easily detected by comparing with the control tube, to which no potassium permanganate is added. The test is read positive, however, only when the solution stays clear. The diazo-reaction, especially if maintained, is unfavorable.

(3) *Hygienic Surroundings*.—When the hygienic regimen under which the patient lives is the best, the prospect is more hopeful than when it is faulty. A proper diet aids favorable progress, while a defective one often turns the scales against recovery. Equally influential for good is a pure atmosphere, while, *per contra*, a vitiated one is injurious. Coni and others have shown by vital statistics a constant increase in the tuberculosis mortality during the years of the World War.

(4) *Age*.—In young subjects from five to fifteen years of age tuberculosis often pursues an acute course and the mortality rate is exceedingly high. Chronic tuberculosis may, however, form a sequel, and under appropriate surroundings may lead to recovery. In chronic phthisis "the younger the patient, the shorter the duration." I have observed that patients who give a history of pleurisy early in life do not bear chronic phthisis well. Naegeli found, as the result of 500 autopsies at Munich, that in persons over thirty years of age every one had been more or less successfully attacked by the *Bacillus tuberculosis*; but from the fact that most deaths had occurred in subjects under thirty he concludes that the adult body is well able to resist the attack. "The absence of a tuberculous family history has but slight if any favorable significance" (Bonney). During old age tuberculosis is usually more or less latent, and, owing to coexistent emphysema and chronic bronchitis, pursues a slow course. In *renal tuberculosis* the possibility of a cure in open tuberculous pyelitis is, to say the least, rare, while the so-called closed parenchymatous form more often heals anatomically.

¹ *British Jour. Tuberculosis*, London, October, 1914.

² *Wein. klin. Wchnschr.*, Vienna, October 16, 1913.

the phthisical tendency the physician must place chief reliance upon the most favorable environment attainable. The value of a change of residence—from the city to the country, the seaside, or the mountains, in selected cases—cannot be overestimated. It often renders predisposed persons immune. For some, and particularly young subjects, an equable climate (Southern California or Florida) that will enable them to live an outdoor life is to be preferred. Attention to the food must not be forgotten. Milk and raw eggs are excellent and should be used freely. Daily sponging of the neck and thorax with cold water is beneficial, and appropriate light gymnastics should be instituted if the subject be old enough. Indoor occupations are to be forbidden and the ventilation of living- and bed-rooms must be looked after carefully.

Tuberculosis is apt to develop especially in children while convalescing from acute fevers, and hence during this period the child should be strengthened by vigorous feeding, pure air, and tonics. In children predisposition often results from obstructions in the nose and from persistently enlarged tonsils; and they should be promptly removed. All local foci of tuberculosis in children—glandular, osseous, and articular—must be attacked surgically. “Any campaign against tuberculosis which leaves out of consideration the protection of children against infection will fail of success” (Ravenel). Angel insists that the best prophylaxis against tuberculosis is by medical inspection in the schools, and the segregation of the weakly and backward in a special school, where they could be trained in body and mind.

In removing the diathesis, medicines are unquestionably of less value than the hygienic treatment, the latter in the widest sense of the term aiming to reinforce Nature's efforts at spontaneous recovery, and embracing four main elements: (1) Climate; (2) feeding; (3) rest, and (4) exercise.

Treatment of the Disease.—(1) **Climate.**—The all-powerful influence of environment has already been pointed out. Experience and observation have shown that certain climates, selected with particular reference not only to the stage of the affection, but more particularly to the individual, are useful modifying influences of the tissue soil. In any case of tuberculosis that climate is most suitable in which the patient “feels well, eats well, sleeps well, and gains flesh and strength” (Delafield). Until the patient finds such a climate, or if he finds no single climate to produce these results, he should travel from place to place, unless special contra-indications (excessive debility, etc.) exist. If active tuberculosis has existed, the stay in a suitable climate should not be less than two full years.

The climatic requisites for a consumptive are: (a) purity of air, (b) equability, and (c) abundant sunshine. Less beneficial, though important, are (d) dryness and (e) altitude.

(a) *Purity of Air.*—This requirement is of paramount importance, and this explains why mountain air is so helpful in phthisis.

(b) *Equability* has reference to the absence of rapid variations of temperature. On the whole, a relatively low is better than a high temperature, the former being stimulating, and the latter sedative, in effect. It should be pointed out that forests greatly favor the quality of equability,¹ both as to temperature and relative humidity. They tend to minimize the diurnal variations of temperature—a point that is of greater importance than the question of seasonal variations. Forests intercept and temper the bleak winds of winter, while by their shade and leaf surfaces they afford a cooler temperature in summer.

(c) *Abundance of sunshine* is demanded by the consumptive. The advantages of sunshine are obvious from the observations made by Munn in the year

¹ Anders: *House-plants as Sanitary Agents; Sanitary Influence of Forest Growth*, p. 312.

1893, when in Denver there was sunshine in 62 per cent. of the possible hours during which it could occur. A *dry* atmosphere has advantages, but that dryness is not an essential element is shown by the fact that patients often do well at places having comparatively high relative humidity, such as Florida, Southern Georgia, Southern California, and the resorts on the south coast of England. The *rarefied* atmosphere of high altitudes, on account of its stimulating effect upon the respiratory function, aids in producing good results, but the pulmonary changes induced (enlargement of the air-cells, with augmentation of the size of the chest) make it necessary for patients to remain for the rest of their lives. That it is not an essential factor is shown by the excellent results obtained in the oftentimes purer atmospheres at lower levels. Cases in which hemoptysis is severe and of frequent occurrence, those complicated with weak hearts, and neurasthenic subjects should not be sent to the high altitudes.

The essential climatic factors mentioned are found in certain American and European resorts. Of the former, the Adirondack region, Colorado, Arizona, and New Mexico are especially to be mentioned, combining as they do in winter a uniform cold, much sunshine, and purity of atmosphere. A camp- or tent-life in the open air is strongly advocated. According to my own experience, the Adirondacks meet the indications best in early cases or in patients who have strength enough to lead an outdoor life, and in whom the breaking-down stage is not too far advanced. Some cases in the early stage also do well at Thomasville, Ga., Southern California, and at Lakewood, New Jersey. Some of these resorts possess the added advantage of affording an opportunity of gaining a livelihood. Among foreign resorts, Davos possesses about the same advantages as may be met in Colorado, New Mexico, and the Adirondacks, while the resorts in Southern Italy and France are comparable to Southern California, Southern Georgia, Florida, and the Bermudas in this hemisphere. Good culinary and home comforts are considerations of no less importance than the climate.

Briefly, the atmosphere of forest resorts possesses certain unmistakable advantages for this group of sufferers. Hence they should be sent into the neighborhood of the nearest forest in mild latitude (if they cannot enjoy the advantages of more remote resorts), where reasonably good food and other comforts of life are obtainable. The superior value of the highly oxonized and terebinthinized atmosphere of the pine-groves in laryngeal tuberculosis cannot be too strongly emphasized.

Sanatorium Treatment.—While it is essential to send patients to suitable resorts, the most satisfactory results are obtained from the combined climatic and sanatorium treatment. Sanatoria are warmly advocated by Trudeau, Knopf, Bowditch, and others. Of 237 early cases treated in the Sharon Sanatorium, 81 per cent. were known to be alive and in excellent health for at least one year after leaving the institution.¹ They should take the form of cottages and pavilions. The principal advantages offered are due to a rigid system of hygiene under the close supervision of competent medical officers. There are *four groups of cases* among the middle and lower classes that require institutional treatment:

Group I.—The numerous cases that have progressed to an advanced and practically hopeless stage and the acute forms. These require every comfort and kind care, such as can be furnished by *special hospitals* for consumption in a healthful urban locality.

Group II.—Incipient cases among the pauper element. For these, sanatoria located close to large municipalities, though with special reference to

¹ V. Y. Bowditch and W. A. Griffin, *Jour. Amer. Med. Assoc.*, December 24, 1912, 2132.

uch factors as purity of atmosphere and protection from chilly blasts, by natural elevations or the woodland, should be provided.

Group III.—Phthisis pulmonalis among the middle and working class, or persons having small means. The members of this group will find themselves compelled to depend principally upon private philanthropy, and probably to some extent also upon semi-State institutions; they need sanatorium treatment in the best climates, and there is no valid reason why the combined sanatorium and climatic treatment should not be attempted, since such an undertaking could be made almost self-sustaining.

Group IV.—“A settlement for patients with arrested consumption where they can be employed on work adapted to their strength” (Powell.)

In Denmark a system of classification embraces (a) sanatoria for curable cases, (b) hospitals for advanced cases, and (c) special institutions for those able to work.

Among *home sanatoria* are the Adirondack Cottage Sanitarium, the Sharon Sanitarium, near Boston, the Loomis Sanitarium, at Liberty, N. Y., the Winyah Sanitarium, at Asheville, N. C., the White Haven Sanitarium and the various State sanatoria. *Foreign sanatoria* are to be found at Falkenstein, near Frankfort-on-the-Main, Goerbersdorf, and Hohenhonnef. *Solaria*, in connection with city hospitals for advanced cases, would I am certain, yield gratifying results. Home sanatoria can be readily improvised by stocking living apartments with growing plants. The beneficial influences arising from the presence of the latter are ascribable to two functions—the generation of ozone and transpiration. Tuberculosis dispensaries and classes are highly recommended in the treatment of tuberculosis among the poor and persons having small means. The class method is useful as an object lesson to teach the essentials in the home that are taught to the individual in a sanatorium (Wood).

Open-air Treatment at Home.—This method is now widely practised. It has been well said that the consumptive need not necessarily migrate to secure restoration to health. He should be kept constantly in the open air, and for the most part at rest. At night the bed-room windows should be open, even in severe weather. Indeed, sleeping in the open air on a veranda, porch, or the roof is to be advised and encouraged, and ingenious contrivances have been invented whereby the patient can occupy a bed out-of-doors at all seasons of the year. With warm clothing, abundance of good food, especially raw eggs and milk, and a careful regimen surprising results are obtained even in large cities. In my opinion, however, most tuberculous patients, at all events, require the rigorous discipline of a sanatorium for a variable period of time so that they may acquire proper habits of living. Such a sanatorium for the reception of indigent patients should be situated in their home climate. The experiment has already been made in Chicago and other cities with complete success. Flick, Minor, and Coleman are of the opinion that tuberculosis patients can be successfully treated in their homes and other places than sanatoria.

(2) **Feeding.**—The diet should be both nutritious and generous. Too close attention cannot be bestowed upon the feeding. Above all, when the remedies prescribed embarrass in the slightest degree the function of the stomach they must be stopped.

Such albuminous articles as milk, eggs, flesh, fish, and fowl, together with an abundance of fats, should be taken. The carbohydrates are urgently needed, but they must be taken with care lest they derange the digestive function. Overalimentation with raw eggs and milk is strongly advised if the digestion is not impaired. The eggs are to be slightly beaten and stirred into the milk

acts merely as a fatty food. It may rarely cause further impairment of the appetite and digestion, or set up intestinal disturbances, when its effects are harmful. The commencing dose should be small (3j—4.0, once or twice daily, to be increased after a time to 3ij—8.0, two or three times daily). It should be taken about mealtime. When the oil is not well borne, it may be given in combination with an alkali (lime, soda). As a substitute for cod-liver oil, cream, preferably Devonshire, may be tried (3ij to 3ss—8.0 to 15.0, three times daily).

The *hypophosphites* are serviceable in cases attended with gastro-intestinal disturbance. The dose is 3j to ij (4.0–8.0) thrice daily, after food.

Arsenic is warmly advocated for its general influence in this disease. The dose should be small, so that it may be given for a long time without interruption. As sodium cacodylate, its use has increased of late. Jacobi speaks highly of *digitalis* in tuberculosis in children.

Specific Therapy.—(1) *Chemotherapy.*—All over the civilized world efforts have been made to produce a specific tuberculocide—some drug, synthetic or otherwise, that will have a specific and direct action on the tubercle bacilli. The results as yet achieved are only hopeful at the best. The most promising reports come from Japan, where Koga¹ has produced a drug which he calls cyanocuprol, a salt of copper and potassium cyanid. With this drug the results in the first and second stages of the disease have been truly remarkable, according to the author. Unfortunately, however, the special preparation of this salt is not given by Koga in his paper, and apparently it will remain a secret, at least until put upon the market as a proprietary preparation.

(2) *Tuberculin.*—After the tragic results that followed the use of tuberculin in large doses when first introduced by Koch, the method fell into disuse. It has only been within the past few years that this specific type of treatment, which held out such great promise, has been able to overcome the prejudice against it, and has come into more or less general use by those who are specializing in tuberculosis. Mindful of the past, the present-day tuberculin advocates employ but the most minute dosage (0.0000001 gm. O. T.), which is gradually but slowly increased in amount. Many types of tuberculin have been put upon the market or are prepared at various laboratories. They include O. T., old tuberculin; B. F., bouillon filtrate; T. R., tuberculin residue; B. E., bacillary emulsion, etc. The details of the treatment are too long to incorporate in a book such as this. Furthermore, it is advisable to learn the methods of dosage at first hand, as the inherent dangers of tuberculin therapy are such that the drug should only be given after one has learned thoroughly how it should be done. Suffice it to say that the field of usefulness is rather limited; in fact, some men skilled in the handling of tuberculosis advise its administration only in long-continued chronic cases which under the best of treatment show no improvement.

(3) *Artificial Pneumothorax.*—The collapse of the lung by means of intrapleural injections of a gas, in order to put the pulmonary tissue at physiologic rest, is a type of treatment that is specific in that it is used for a specific purpose rather than for any direct effect upon tubercle bacilli. K. Henius² ascribes the good effects to lymph stasis and hyperemia, which, in turn, induce renewed growth of connective tissue. It is the most marked improvement and addition to the therapeutics of pulmonary tuberculosis that has appeared for many years, and the results that have been achieved, although as yet sufficient time has not elapsed to form definite opinions as to the end-results, would seem to indicate that this method is a very real advance in the hand-

¹ *Jour. Exper. Med.*, 1916, xxiv, 107.

² *Deutsche med. Wchnschr.*, Berlin, October 23, 1919, 1178.

ling of tuberculosis of the lung. The method was originally used in only far-advanced cases, but the present tendency is to employ it in early cases. As Otis says, the "two universal accepted indications have been: extensive unilateral, progressive, or chronic lesions which fail to respond to the ordinary hygienic-dietetic treatment, the opposite lung being comparatively free from disease, and recurring more or less severe hemoptysis or a single severe hemorrhage which fails to yield to ordinary treatment." In general, it may be said that the treatment is used in those cases in which the usual hygienic methods are not proving successful and in which complications, such as abscess, have arisen. The method cannot be used when the lung is bound down by adhesions, though repeated injections of small amounts of gas apparently seem to be able gradually to overcome the restraining traction of adhesions. Likewise it is not advisable in the majority of cases to employ artificial pneumothorax in the presence of bilateral lesions unless on one side the lesion is apparently small and inactive; nor when there is severe tuberculosis elsewhere, *e. g.*, in the intestines; nor when severe cardiac or renal disease exists; in persons who are alcoholics; when grave complications are present; when there is pleurisy with effusion, or when the abdomen is distended with gas.

There are several types of apparatus to be used in the induction of artificial pneumothorax upon the market, of which Dr. Robinson's is to be recommended as convenient and complete. All of them are constructed upon the same general principle: two movable glass reservoirs, one for the gas, the other for water, a manometer, rubber connecting tubing, and a good needle are the essential component parts of the instrument. When the gas (nitrogen is usually employed, though filtered atmospheric air is sometimes used, particularly at the first injection) is to be injected it is run into one of the bottles from the gas tank. The needle, under antiseptic precautions and with local anesthesia of the skin, is run into the pleural cavity at right angles to the chest wall. When the pleural sac is reached the typical respiratory negative pressure oscillations are seen in the manometer. Then only is the gas allowed to run in slowly under slight pressure, the water in the one bottle slowly replacing the gas in the other bottle and causing the requisite amount of pressure. At the preliminary inflation between 250 and 500 c.c. are injected. Subsequently injections of 100 to 400 c.c. of gas are given every few days until the lung is collapsed. When this is achieved the following injections are given about every ten days for a while, until after a time the period between injections can be prolonged to three or four weeks. The result of the collapse as well as the conditions preceding should be carefully studied by the roentgen rays.

The immediate effect of the injection is to cause considerable tachycardia and increase of symptoms, but in a short time there occurs a marked amelioration of the symptoms if the collapse is satisfactory. Occasionally complications occur, but they are extremely rare if a proper technic is followed out. Of these, the most dangerous is the so-called pleural reflex, shock, and collapse following the introduction of the needle into the pleura. Other less grave complications include gas embolism, deep or subcutaneous emphysema, serious pleural effusion, infection, displacement of the heart, puncture of the lung, and rupture of the mediastinum.

Sachs¹ has reviewed 1145 cases thus treated by twenty-four American observers. Benefit resulted in 29.9 per cent. of 1108 cases, while the effect was merely palliative in 21.7 per cent. It would appear from these figures that the method is applicable in only a little over half of the cases. From our present knowledge it is not known when to expect the development of a spontaneous pneumothorax, which rarely occurs during the course of an induced pneumo-

¹ *Jour. Amer. Med. Assoc.*, November 27, 1915, p. 1861.

thorax (Marshak and Craighead¹). Raymond and François² strongly advise the intraspinal injection of air as a curative agent.

(4) The *Roentgen rays* have been recommended in the treatment of pulmonary tuberculosis, as the result of research work done under a subsidy from the Koch foundation. The principles for application and the technic are the same as for superficial tuberculous processes. Ernst Amstad combines heliotherapy and Roentgen rays in certain forms of the disease, especially gland cases and tuberculosis of the peritoneum. Active fever is a contraindication. Elliott³ also lauds heliotherapy in abdominal tuberculosis.

Treatment of the Acute Forms.—The treatment of acute tuberculosis is an expectant one. The special measures recommended above should be tried, but are rarely effective, and a change of climate is inadvisable. Supportive measures, such as stimulants and nutritious aliment, are required. The medicinal treatment must be adapted to the acute febrile condition, but all depressants are to be avoided. Special symptoms may be relieved in accordance with general principles.

In *renal tuberculosis* recent experience confirms anew the importance of prompt nephrectomy. Castaigne reports 5 cases in which he used tuberculin or Spengler's immunizing bodies, or both, with ultimate success. Barney recommends epididymectomy in cases of tuberculous epididymitis. In tuberculous peritonitis Hoffmann advises opening the peritoneal cavity, evacuating the fluid, if present, and painting the peritoneal surfaces of the gut and abdominal wall with 10 per cent. tincture of iodine. In *tuberculous meningitis* Meyers found in 105 cases spinal puncture to relieve or prevent convulsions, while neither large doses of sodium benzoate, inunctions of mercury, nor hexamethylenamin were of any value in this form of the disease. In *tuberculous adenitis* the roentgen rays should be employed early. Before the removal of tuberculous lymph-nodes is advised foci elsewhere in the body should be excluded. The *puerperal state* exerts an aggravating influence on the bacillary process in most cases, hence Farani would sacrifice the fetus to the mother the more readily, the better the tuberculous mother's condition. Pregnancy should be terminated early in these cases (prior to the fifth month), after which every means should be applied to help the mother to throw off the tuberculosis. Tuberculous women should not marry unless the pulmonary lesions have been quiescent for a moderately prolonged period (Norris and Landis).

Treatment of Leading Symptoms.—(a) *Cough.*—This is often quite annoying. The special cause or causes of the coughing should be determined before any attempt is made to treat it. When attributable to catarrhal irritation of the upper air-passages it is best treated by topical applications. The following substances may be inhaled: compound tincture of benzoin combined with paregoric or carbolic acid; formalin; creasote, alcohol, and chloroform in equal parts. For local applications by means of the spray sedatives and narcotics should be preferred, and a solution of cocain is sometimes most efficient. The cause may be found in pleurisy or pleuritic adhesions, and for this condition counterirritants, as iodine, sinapisms, etc., may be used. Pleuritic coughs often demand codein or even morphin in moderate-sized doses. The cough is in most instances occasioned by the tuberculous bronchitis, and to a lesser extent by the vomicae. Cough mixtures as usually formulated are apt to disorder the digestive function, and in so far as they have this effect they are positively harmful. Syrups should be omitted from their composition. Creasote by inhalation is the remedy *par excellence* for tuberculous bronchitis

¹ *Review Tuberculosis*, November, 1917, p. 540.

² *Bull. de la soc. med. des hôpît.*, October 26, 1917, p. 1058.

³ *Canada Med. Assoc. Jour.*, 1917, vii, 420.

combined with spirits of chloroform and alcohol. When expectoration is copious, preparations of terebene, terpin hydrate, and tar may be resorted to; and when the cough becomes distressing I employ codein (gr. $\frac{1}{8}$ to $\frac{1}{4}$ —0.008–0.016, every three or four hours) in the form of a granule. In the later stages morphin is allowable, since it is at this time that constant coughing or severe paroxysms of cough, if not restrained, lead to utter exhaustion. Heroin, in doses of gr. $\frac{1}{8}$ to $\frac{1}{12}$ (0.01–0.005), three or four times a day, acts beneficially in allaying the cough that accompanies phthisis. Stimulant expectorants may be needful, and ammonium carbonate in the infusion of wild-cherry bark is perhaps most efficacious; a few drops of the deodorized tincture of opium or spirits of chloroform may be added.

(b) *Fever*.—Creasote has found a slight field of usefulness in the treatment of the fever of tuberculosis. In my experience at all events, the cases in which it has been used, as above indicated, have shown a greatly diminished febrile movement. Cold or tepid spongings of the body at intervals of one, two, or three hours, according to the intensity of the fever, should be tried. Internal antipyretics are rarely advisable, since during the period of high temperature the cardiac action is much enfeebled; but if urgently called for, the following may be employed: acetanilid (gr. ii–iii—0.13–0.2), phenacetin (gr. iii–v—0.2–0.3). These are to be administered about two hours before the commencement of the daily rise in temperature, and repeated every three or four hours if necessary. Other antipyretics worthy of trial are the mineral acids and zinc oxid. Keeping the patient at complete rest when there is fever is of the utmost importance, though he should be wheeled into the fresh air for as long a time as possible during the day.

(c) *The Night-sweats*.—Among remedies that control the sweats most successfully may be mentioned: atropin (gr. $\frac{1}{120}$ to $\frac{1}{80}$ —0.0005–0.001); zinc oxid (gr. ii to v—0.13–0.32); sulphuric or gallic acid; agaricin (gr. $\frac{1}{8}$ to $\frac{1}{4}$ —0.008–0.016). Calcium chlorid is warmly recommended by Peperhowe. Sponging with equal parts of alcohol and tincture of belladonna is very effective, but my own best results have been derived from the use of atropin (gr. $\frac{1}{120}$ to $\frac{1}{80}$ —0.0005–0.0007) in combination with agaricin (gr. $\frac{1}{8}$ —0.008).

(d) *Secondary Anemia*.—Bullock and Peters recommend subcutaneous injections of citrate of iron (0.05 gm. injected daily). Barlow and Cunningham advise the subcutaneous or intramuscular injection of arsenic or iron, or of the two in organic combination.

(e) *Dysphagia* may be a troublesome symptom, especially from involvement of the larynx, and it is best met by local applications of a solution of cocain in glycerin and water (gr. x to ʒj—0.6–30.0), thrice daily before meals. In advanced cases I have resorted to hypodermic injections of morphin (gr. $\frac{1}{8}$ —0.008) before meal-time.

(f) *Gastric Disturbance*.—In nearly all cases of phthisis dyspeptic symptoms come on sooner or later, and for this gastric disorder nothing is so important as a proper regulation of the diet. Perhaps the medical treatment of the stomach symptoms has been dealt with at sufficient length, save that of vomiting, which may come on after meals and constitute a distressing concomitant. Those remedies giving the best results may be adduced as follows: Cerium oxalate (gr. v to viij—0.32–0.51), in capsules before meals; calomel and soda in fractional doses; dilute hydrocyanic acid (ʒii to iij—0.13–0.2); and chipped ice with brandy sprinkled over it, taken at short intervals, but especially shortly before meal-time.

(g) *Diarrhea*.—The most important factor in the treatment of this symptom is a properly restricted dietary. Alum whey, mutton and chicken essence are of service, but curds of milk, beef-tea, and solids are not suitable. Of the numerous medical measures that have been employed, the most useful are

smuth subgallate, lead acetate, opium, thymol, salol, benzonaphthol, and phthalin. To these may be added the following acid diarrhea-mixture, each one containing—

R.	Acid. acetici dil.	℥x	(0.6);
	Morphinæ acetat.,	gr. $\frac{1}{8}$	(0.008);
	Plumbi acetat.,	gr. i-ij	(0.065-0.13).

Complications when they arise must be dealt with according to accepted therapeutic principles.

(h) *Hemoptysis*.—As a rule the ordinary case of hemoptysis will be controlled by absolute rest in the recumbent position, together with a hypodermic of morphin to assist in keeping the patient quiet and to limit cough. In intractable cases, however, these measures frequently fail and recourse must be had to other methods. Drug therapy includes the use of pituitrin, which Wiggas has shown elevates systemic arterial pressure, but lowers the pulmonary pressures. The nitrites are also of value in some cases. Emetin has been used purely on empirical grounds, and apparently has given satisfactory results; but its use is not to be recommended as it is a decided cardiac and respiratory depressant. Methods to increase the coagulability of the blood and decrease the bleeding time include sodium chlorid, blood-serum, coagulose (precipitated horse-serum), and coagulin (dried blood-platelets). Normal horse-serum is prepared and marketed in 10 c.c. syringes, ready for injection. A syringe-ful may be given and repeated in an hour or so if hemorrhage does not stop. Directions for the preparation of the last two compounds accompanies the package in which they are for sale.

Occasionally, when in spite of the methods suggested above hemoptysis persists and is uncontrollable, collapse of the lung by production of artificial pneumothorax is indicated. If the lung can be collapsed, even partially collapsed, the bleeding will promptly cease.

Results of Treatment.—In order to unify the results of treatment and to have a standard whereby reliable statistics might be compiled, it has been recommended by the National Association for Study and Prevention of Tuberculosis that the following scheme be employed to show the results of treatment and the condition of patients on discharge from sanatorium, hospital, or dispensary care.

Cured	{ All constitutional symptoms and expectoration with bacilli absent for a period of two years under ordinary conditions of life.
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Apparently cured	{ All constitutional symptoms and expectoration with bacilli absent for a period of six months, the physical signs to be those of a healed lesion.
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Arrested	{ All constitutional symptoms and expectoration with bacilli absent for a period of three months; the physical signs to be those of a healed lesion.
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Apparently arrested	{ Absence of all constitutional symptoms; expectoration and bacilli may or may not be present; physical signs stationary or retrogressive; the foregoing conditions to have existed for at least two months.
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Improved	{ Constitutional symptoms lessened or entirely absent; physical signs improved or unchanged; cough and expectoration with bacilli usually present.
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Unimproved:	All essential symptoms and signs unabated or increased.
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Died.

Modes of Infection.—The disease is transmitted by contact; but Widal and others, who have studied the disease as it exists in the Hawaiian Islands, think that leprosy is contagious only by inoculation. Long's experiments point to transmission by means of the bedbug. Both mosquitos and bedbugs have been found infected by the leprosy organism and a suggestive bacillus has been found in rats. Morrow's view, that, like syphilis, leprosy is generally transferred by sexual intercourse, receives support. Hansen holds that the infection atrium is unknown; he thinks it probable, however, that the mouth and nasal cavities are the avenues of entrance. Sticker also regards the nasal mucous membrane as the primary focus, and finds in it constant lesions. The bacillus has been found in the floors and walls of houses in leper colonies, and also from the urine and even the milk of patients. Healthy nasal carriers have been observed.

Clinical History.—Two forms are recognized, the *tubercular* and the *anesthetic*, but neither of these runs its entire course without developing into a third or mixed form.

The *incubation* is usually long (three to five years—Hansen). It may rarely be shorter or much longer. Vague *prodromes* are present for years (drowsiness, chilliness, recurring attacks of fever, debility).

(1) **Tubercular Form.**—In the first stage there is a patchy, cutaneous *erythema* with a slight hyperesthetic elevation of the affected areas (*macular leprosy*). These are oftenest seen on the face, the extensor surfaces of the arms and knees. They may vanish and leave the skin pigmented and anesthetic, and later the pigment may disappear, while white spots of corresponding size remain (*lepra alba*).

When the disease progresses less favorably tuberculous *nodules* (dusky red or almost brown in color) develop in addition to anesthesia. The small ones soon disappear, while the large ones are either absorbed or break down and ulcerate—changes which, as they advance together with the slow healing process, produce marked deformities. The *skin* is greatly thickened and presents a scaly surface, and there is loss of substance in certain parts, while others are enormously enlarged (eyebrows, nostrils, lips, etc.). Among the many symptoms pointing to involvement of the mucous membrane are *ozena*, *hoarseness*, or even *aphonia*, and the signs of *inhalation-pneumonia*. Blindness often ensues as the result of extension of the process. To ulcers extending deeply into the mucosa of the pharynx and larynx death may often be ascribed.

(2) **Anesthetic Form.**—In this variety the *local symptoms* point usually to implication of the nerves. At the onset there are *pain* and *patchy hyperesthesia*, while minute bullæ, due to trophic changes, put in an appearance on the arms and legs. The *muscles* supplied by the branches of the affected nerve-trunk waste, and the superficial nerves feel thickened and nodular. Mourao describes a new sign the result of wasting away of the muscles on the ulnar side of the hand and the muscles of the inner aspect of the foot on the same side, with loss of sensibility. *Bright red patches* of vasomotor congestion appear and soon become anesthetic, while the maculæ disappear. *Anesthesia* may proceed without the latter eruption. Dry, yellowish-white, scaly patches upon the trunk and extremities are also visible. Early their centers alone are anesthetic, but subsequently the loss of sensation spreads even to healthy portions of the skin.

Trophic alterations reach an extreme degree. Bullæ appear, and, bursting, leave perforating or destructive ulcers, usually upon the extremities. As the result of absorption, wasting, and necrosis great deformities are produced. The hands often take on a claw-like form, and the fingers and toes may disappear (*lepra mutilans*).

Diagnosis.—The early diagnosis rests upon the presence of patchy erythema with hyperesthesia, followed by the development of anesthesia, with a disappearance of the muscular eruption. Nodular neuritis is pathognomonic of anesthetic leprosy. Scrapings of the skin lesions frequently show the specific bacilli. In the advanced stages of either form confusion could scarcely arise. Complement-fixation tests are generally positive and specific when the sera of lepers are tested against antigens prepared from lepromas. Between 40 and 90 per cent. of leprosy patients give a positive Wassermann reaction (McCoy). The nodular form of *tubercular syphilis* is distinguished by the distribution of the lesions, the history, the frequent sensory nerve lesions, and by incising the tubercle and compressing serum from it—when lepra bacilli are found in the exudate—bacilli may be found in the nasal secretion. Shoemaker and Boston report an advanced case where lepra bacilli were found in the blood, and collected reports of 20 similar cases from the literature.

Prognosis.—Leprosy runs a very chronic course, lasting sometimes two, three, or more decades. The prognosis as to the final issue is hopeless, but the patient may live in comparative comfort for many years before the ravages of the disease cause great mutilation. Honeij considers the change in morning pulse-rate—higher than at evening—as an index to the condition of the patient. Certain diseases are supposed to exercise a retarding effect on leprosy (erysipelas, pneumonia, variola, phthisis).

Treatment.—The disease has thus far resisted all methods of treatment. Matthews treated 7 cases representing both kinds of leprosy with roentgen rays and high frequency, and concludes that it is the only method which has produced any real effect on the progress of the disease. *Internally*, chaulmoogra oil has been employed with excellent results. Dyer says that it is the only remedy producing consistently good results. It is administered in pearls or capsules (each containing mij to v —0.2 to 0.3), in ascending doses, until the limit of tolerance is reached—from 50 to 150 minims (3.08–9.24 c.c.). Heiser, working among the Filipinos, gives the drug hypodermically. L. Rogers¹ has recently proposed the use of sodium gynocardate intravenously as a promising remedy in the anesthetic cases. In a still later report Rogers² finds that the combined intravenous and oral administration of sodium salts of the fatty acids of chaulmoogra oil will effect a cure in many cases in from one to two years. In still more recent work (1919) Rogers and Muir have employed a sodium salt of the fatty acids of cod-liver oil with equally good results as far as the cases had gone. Surgical interference may become necessary. Manson advises free excision if only one tubercle, and no signs of a general invasion, be present. Segregation of lepers has been instituted in certain localities.

GLANDERS

(*Farcy*)

Definition.—An infection of equine origin, caused by the *Bacillus mallei*. Two forms are recognized—*true glanders* and *farcy*.

Pathology.—The characteristic lesions are new growths (granulomata, according to Virchow), which are usually nodular in character, though they may be diffuse. These masses soften and form ulcers when they occur on the nasal mucosa, and abscesses when they are situated subcutaneously. Microscopically, the nodular tumors are composed of cells—lymphoid and epithelioid—together with the specific bacillus.

¹ *Brit. Med. Jour.*, October 21, 1916, 550.

² *Indian Jour. Med. Res.*, 1917, v, 277.

Etiology.—The morbid changes above described are caused by a specific organism, the *Bacillus mallei*, which resembles closely the tubercle bacillus, though it is a little thicker as well as shorter. It is non-motile. It can be readily grown, and as readily inoculated into horses, in which it produces the disease with every characteristic symptom. Perhaps the simplest method of staining the *Bacillus mallei* "is to treat a cover-glass preparation with warm carbol-fuchsin (preceded by acetic acid), and then wash it off with a 2 per cent. solution of nitric acid."

Modes of Infection.—The virus is, as a rule, transferred directly from the infected animal to man, hence the disease occurs almost invariably among males and persons who come in contact with horses (hostlers, coachmen, soldiers, veterinarians, and farmers). Transmission from man to man has been observed, but rarely. The medium of conveyance is either the *pus* or the *nasal secretions*, which may drop or be blown from the animal's nostrils upon a wound in the skin or mucous membranes, however slight, and be absorbed.

Immunity.—The disease is rare in man because of natural immunity. Singer has produced artificial immunity by intravenous injections of sterilized cultures of the glanders bacillus.

Clinical History.—The duration of the *incubation period* is from three to five days, and rarely longer. Both glanders and farcy may be *acute* or *chronic* in their course.

(1) **ACUTE GLANDERS.**—At first the signs of inflammation develop at the point of infection, *lymphangitis* and swelling of the adjacent lymphatic glands being associated. *Fever* and other evidences of general disturbance soon appear, and at the end of two or more days the nasal mucosa becomes implicated, ulcers forming, from which a fetid mucopurulent (sometimes blood-streaked) discharge takes place. *Nosebleed* is common. Later an *eruption* comes out on the face, the trunk, and the extremities, particularly about the joints. It is papular, quickly becoming pustular, and the pustules may dry up while fresh papules are developing—a characteristic feature. The *face*, particularly the nose, now swells, and a bluish-brown tumor covered with vesicles appears. Implication of adjacent mucous membranes—conjunctivæ, pharynx, mouth, etc.—is usual, and less frequently the bronchial and gastro-intestinal mucous membranes are involved. The ulcerative processes may extend to the bones, setting up necrosis. True arthritis occurs in 10 per cent. of the cases (H. Morel). Bronchopneumonia is a common complication.

(2) **CHRONIC GLANDERS.**—A rare disease with mild but vague general symptoms, as muscular and arthritic pains, fever at intervals, asthenia, and progressive wasting, and the local features of nasal catarrh, with a bloody mucopurulent discharge. Cough may be present.

(3) **ACUTE FARCY.**—In this form the virus is inoculated into the skin, which presents the chief symptoms, the nasal condition being in abeyance or absent. The primary lesion is of an aggravated type, accompanied by numerous cutaneous boils and abscesses, often following the line of the lymphatics. Their favorite seat is in the vicinity of the joints. The constitutional symptoms simulate those of acute pyemia.

(4) **CHRONIC FARCY.**—Granulomatous tumors, resulting in abscesses, constitute the chief clinical peculiarity. The abscesses are situated primarily in the subcutaneous tissues, and often near the joints. As a rule they open spontaneously and discharge, first a thick, creamy pus, and later a thin, fetid material. They sometimes form distinct ulcers, extending in depth until the bones are involved.

The *general symptoms* simulate those of chronic glanders, the fever-curve

the blood, the following: (1) The anthrax bacillus has the form of a rod of length varying from 5 to 20 μ , and in breadth from 1 to 1.5 μ . It is broken up into short articulations from 1.5 to 2 μ long, placed end to end like the articulations of a tenia, the ends of each articulation being slightly swollen, giving the appearance of a bamboo cane; (2) clear spaces, appearing like a biconcave lens, exist between the ends of the articulations, and result from the slight concavity of these ends; (3) a capsule, often distinctly marked, surrounds the rod, seeming to form a protoplasmic support for the individual articulations. These threads of anthrax bacilli stain best with Löffler's blue. They grow readily on various media (agar, gelatin, potatoes, etc.) into interlacing thread-like filaments which distinctly show spore-formation, the threads assuming the appearance of strings of beads. The spores resist desiccation, many of the germicides, and boiling water even for a few minutes. Inoculations are followed by the production of the pustule of anthrax.

Modes of Infection.—The *virus* (spores) gains entrance into the human body through the skin (slight wounds, abrasions, or scratches), the intestines (with food), or through the lungs (rarely). Norton and Kohman met with a case of anthrax in a soldier in which the bacillus was found on a new shaving brush. The sting of insects (mosquitos, flies) may also transfer the poison to man.

Predisposing Causes.—*Occupation* is most influential: persons who come into direct contact with infected animals (hostlers, butchers, shepherds), and workers in factories who handle the hair or hides of such animals, being liable.

Immunity.—Pasteur's well-known protective inoculation with attenuated virus has been extensively practised in anthrax localities, with very favorable results. Peterman, however, reinvestigated the question of immunity by the albumose of anthrax, and found it without protective action, except in the case of cultures on ox-serum, which, when injected in large quantities into the veins, conferred temporary immunity.

Clinical History.—The period of incubation is from one to three days. Two leading types are distinguished:

(1) **External Anthrax.**—(a) *Malignant Pustule.*—At the point of infection (the hand, arm, neck or face, or other exposed part) a small *papule* first appears, and develops into a *vesicle* of considerable size with bloody contents (no pus). This vesicle breaks, leaving a characteristic dark-bluish or black *scab* (anthrax), and encircling the primary vesicle an areola of miliary vesicles may be noticed. The base of the original vesicle now becomes swollen and indurated, and this brawny edema spreads rapidly to the adjacent tissues until an extensive area is involved. There is neither burning pain nor tenderness present. The neighboring *lymph-glands* may or may not be inflamed; if so, they are apt to be connected with the pustule by red lines (lymph-vessels, veins).

Severe *general disturbances* accompany the local disorder in the course of a couple of days, and comprise fever, decided prostration, sweats, splenic enlargement, and delirium tending toward coma. If recovery occurs, the edematous swelling subsides and the black scab is cast off. In unfavorable instances collapse develops, and the case ends fatally between the fourth and eighth days. In such instances intestinal symptoms (diarrhea) or nervous phenomena of aggravated type may attend.

(b) *Anthrax Edema.*—In a certain proportion of the cases the *systemic infection* is out of proportion to the *local disturbance*, the latter consisting of an edematous swelling without the presence of an eschar. The eyelids (commonly), lips, tongue, and upper extremities may be the seat of extensive swell-

ing, though there is no change in the color of the skin. This is a dangerous condition, and may result in gangrene.

(2) **Internal Anthrax.**—(a) *Intestinal Mycosis.*—In this form certain general, indefinite symptoms are the primary features, such as headache, pains in the limbs, anorexia, languor. Soon acute gastro-intestinal features supervene, sometimes preceded by a chill. As a rule, vomiting occurs, followed by abdominal pains and diarrhea, and the stools often become bloody. Hemorrhage may also occur from other outlets. Other symptoms, as dyspnea, marked cyanosis, and restlessness, are noted, followed sometimes by stupor, general convulsions, or spasms of single muscles or groups of muscles. There is moderate fever and the spleen is enlarged. Death is preceded by collapse.

Interesting *epidemic* outbreaks of internal anthrax have occurred, due both to drinking-water derived from infected wells and also to diseased meat. Murisier has related the history of an epidemic in which 200 persons fell ill after eating meat from a certain cow. The animal was quartered by a butcher who had previously slaughtered an ox afflicted with anthrax, and had not disinfected his instruments; four days after this 25 persons were attacked by the disease.

(b) *Woolsorters' Disease.*—This occurs among the operatives in factories in which imported wool or hair, mostly from Russia and South America, is sorted, and to produce the typical affection the infection must be swallowed or inhaled in the form of dust. *Mixed cases*, or those showing both external and internal anthrax, may be met with among workers in curled-hair establishments and the like. The *onset* is sudden, with a chill that is accompanied by pains in the back and legs, prostration, and a sharp rise of temperature to 102° or 103° F. (38.8°–39.4° C.). The *local* symptoms may either be chiefly pulmonary or gastro-intestinal. The former consist in dyspnea, chest-pains or feelings of constriction, cough, and rarely the physical signs of bronchitis; the latter comprise vomiting and a diarrhea that is followed by collapse, with marked lividity. Nervous symptoms, delirium, convulsions, or coma are often prominent in serious forms; but a fatal ending may occur while the mind is unclouded. The *course* ranges from one to five days.

(c) *Rag-pickers' Disease* ("Haderkrankheit").—This has been identified by Eppinger as the same form of disease as "woolsorters' anthrax." It occurs among the rag-sorters in the paper mills near Graz. Infection occurs in the respiratory tract. The symptoms observed are high fever, followed by collapse, with depression of the body heat, painful and paroxysmal cough, cyanosis, very weak heart, together with the signs of pleuritic effusion and consolidation of the lung.

Diagnosis.—The history (occupation, etc.) and the appearance of the malignant pustule in external anthrax leave little room for doubt. The diagnosis, however, should be confirmed by an examination of the contents of the pustule for the presence of bacilli, and if found they should be cultivated and inoculated upon a guinea-pig or rabbit.

Internal anthrax may be suspected if the more characteristic pulmonary or gastro-intestinal symptoms, together with those of systemic intoxication, develop in persons whose occupation entails exposure. In doubtful cases the presence of bacilli in the blood must be shown.

Prognosis.—In external anthrax occurring in healthy persons the disease often pursues a favorable course; moreover, radical surgical measures have decreased the death-rate decidedly. Internal anthrax, however, is a deadly affection. As regards "woolsorters' disease," those who survive for one week usually recover (Bell).

Treatment.—Prophylactic measures embrace the sterilization and de-

struction of the hair, hides, wool, etc., of infected animals as well as the cremation of their bodies. Subsequent disinfection of the infected premises and the prohibition of grazing in infected pastures are matters of the utmost importance. Dudley states that if disinfection be done thoroughly before spore development occurs an epidemic can be avoided. Sterilization of the patients' hands before meals or the wearing of rubber gloves is suggested to prevent the fatal intestinal involvement. In the carbuncular form, if seen early, the best treatment is excision of the affected area by means of the cautery or knife, including a considerable amount of surrounding skin. In the edematous variety early excision followed by cauterization is indicated. If impossible, as is the rule, injections of carbolic acid in a solution of water and glycerin (1 : 10) into the surrounding tissue have given the best results. Hallopeau recommends that in order to prevent extension the neighboring structures be bathed with a 10 per cent. solution of carbolic acid (first dissolved in alcohol) in oil or glycerin. Internally, stimulants, antiseptics, and nourishing food constitute our chief reliance. In internal anthrax efforts at treatment avail nothing. Several sera have proved valuable in the treatment of anthrax, the best being that of Slavo, which is obtained from the sheep or ass (Emery). Penna, Cuenca, and Kraus record 140 patients treated with normal beef-serum, with the loss of only 1, or 0.71 per cent. The dose ranged from 10 to 30 mil. as the average, up to 40 and 50 in the most intense cases. The dose is repeated on the next and the following day at need.

HYDROPHOBIA

(*Rabies*)

Definition.—A specific, infectious disease peculiar to carnivora and to a less extent to herbivora, which may be communicated to man by direct inoculation. It is characterized by slight fever, spasm of the larynx and pharynx, delirium, a short stage of paralysis, coma, and, in the great majority of cases, a fatal termination.

Pathology.—The fauces, pharynx, and esophagus may be congested, the latter organ being sometimes markedly edematous; pulmonary congestion has also been noticed. The mucous membrane may show here and there points of hemorrhage, and Fitz has observed blood-extravasations into the perivascular spaces of the brain. Soft thrombi may fill the cerebral vessels, especially the veins, while the blood has a dark color and its clots lack firmness.

Balzer, Benedikt, Kolesnikoff, and Schaffer made studies of the changes in the nervous system. Later Babes described the *tubercles rabiques*, which consist of pericellular accumulations of embryonal cells, the latter finally taking the place of the destroyed cell. More recently Van Gehuchten and Nèlis discovered lesions in the cerebrospinal and sympathetic ganglia; they "consist in the atrophy, the invasion, and the destruction of the nerve-cells brought about by new formed cells derived from the capsule, which appears between the cell body and its endothelial capsule. These new formed cells increase in number, invade the protoplasm of the nerve-cell, and finally completely occupy the entire capsule." Rarely the kidneys may show cloudy swelling.

Etiology.—Pasteur has found the poison abundantly present in the nerve-centers, and has transferred the disease by taking bits of brain substance or medulla derived from an infected animal and inoculating them into healthy

ver, but it may be absent; the pulse is moderately accelerated and is sometimes regular, and toward the end of this stage the reflex spasms of the respiratory apparatus develop spontaneously. Mental aberrations and melancholia may ensue, and often lead to suicidal tendencies.

(2) **The Paralytic Stage.**—In the concluding stage the patient passes into actual unconsciousness or coma, without spasms. This lasts from twelve to eighteen hours, ending in death.

In man there is a *paralytic form* of rabies, but it is rare as compared with the delirious or psychic type. Thirty cases have been reported by Gamaléia, and it is apt to follow deep and multiple bites. The paralysis begins near the part bitten, and spreads until it becomes general, finally involving the respiratory centers. In rodents quiet madness ("dumb rabies"), without maniacal excitement, is the rule.

Diagnosis.—The hyperesthesia, the fear of water, the reflex spasms on attempting to swallow, accompanied by dyspnea and great mental agitation, form a very characteristic grouping of symptoms. Bits of brain substance or medulla of the rabid animal that has inflicted a bite should be quickly obtained, and a subdural inoculation of a rabbit be made. If virulent, the paralytic form of the disease will ensue in from fifteen to twenty days. Ravenel and McCarthy, following the method¹ of Van Gehuchten and Nèlis, conclude that when present the capsular and cellular changes in the intervertebral ganglia, taken in connection with the clinical manifestations, afford a trustworthy means of diagnosis of rabies in the animal. When these changes, however, are absent (as happens in early stages of the disease), rabies cannot be excluded. *Hysteria* may be misleading, but here the previous history suffices.

The name *lyssophobia* has been given to cases that simulate, but have no relation to, hydrophobia, and Mills has advanced the warning that, however suggestive the symptoms following a dog-bite, the given case cannot be assumed to be a case of hydrophobia until other possibilities are excluded. It is highly probable that there is a form of hydrophobia which is the result of the wide publicity given to genuine and suspected cases alike. The characteristic symptoms may be present, but the affection does not develop. This so-called *pseudohydrophobia* appears only in neurotic and hysteric subjects. Recovery is the rule. Burr reports an interesting case of the kind that occurred in Osler's clinic, attended, however, with recovery.

Prognosis.—Few if any cases of rabies in man recover if the disease be allowed to develop.

Treatment.—Prophylaxis.—Upon the reception of a bite thorough disinfection, followed by cauterization of the wound with caustic potash, or, better still, excision, if important structures be not involved, is a measure that can be quickly carried out. The wound is then to be kept open for a period of four or five weeks. Dudley advises that a tourniquet should be applied if

¹This is as follows: The ganglion is put at once into absolute alcohol, in which it is left for twelve hours, the alcohol being changed once. It is transferred for one hour to a mixture of absolute alcohol and chloroform; next put for one hour into pure chloroform; then for one hour into a mixture of chloroform and paraffin, and lastly in pure paraffin for one hour. The sections are put in the oven for a few minutes, then passed through xylol, absolute alcohol, and 90 per cent. alcohol, after which they are stained for five minutes in methylene-blue according to Nissl's formula, differentiated in 90 per cent. alcohol, dehydrated in absolute alcohol, and cleared in essence of cajuput and xylol. Ravenel and McCarthy found that the capsular changes were best brought out in sections stained by hematoxylin and eosin. Since these latter changes are the most essential diagnostic features in the sections, they suggest that material unfit for the Nissl method will still show the capsular changes when stained by hematoxylin and eosin.

TETANUS

(Trismus; Lockjaw)

Definition.—An acute, infectious disease caused by the tetanus bacillus. It is characterized by painful spasms, affecting first and chiefly the muscles of the jaw and neck (*trismus*), and second those of the trunk, especially the extensors of the spine and limbs (*opisthotonos*). In certain institutions and certain localities it occurs endemically, and among newborn children and the colored race it may prevail epidemically (*trismus neonatorum*).

Pathology.—No constant postmortem lesions have been found. The virus acts principally upon the nervous centers of the medulla and the cord, producing inflammation (sometimes softening) of the gray substance of the cord. According to Brown-Séquard, the characteristic lesions are consequent upon an *ascending neuritis* starting from the wound. Tetanus neonatorum often shows inflammation of the umbilicus.

Etiology.—Bacteriology.—In 1884 Nicolaier discovered the bacillus of tetanus, and in 1886, Rosenbach first found it in man. It is a long, slender rod, at one end of which appears a swelling due to the formation of a spore in that locality, thus giving the organism an appearance like that of a pin or drumstick. The bacilli are easily stained by Abbott's method, and are purely anaërobic. The spores are extremely resistant, and the ordinary methods of sterilization will frequently be inadequate to kill them. Pure cultures can be made, but with difficulty, since they will not grow in the presence of the smallest amount of oxygen. Mühsam remarks that other germs, which enter the wound with the tetanus bacilli, favor the anaërobic proliferation by consuming the oxygen. The infection is entirely local, but associated with a toxemia exogenous in type. The bacilli and spores never enter the blood-stream, but elaborate a powerful toxin which when absorbed gives rise to the characteristic symptoms. The toxin has a strong affinity for nerve-tissue. It is rapidly produced and may be absorbed within twenty-four hours after infection. Antitoxin, if given in sufficient amounts, can neutralize the toxin until the body-cells have destroyed the organism and its spores. The toxin, according to Ehrlich, is made up of two substances, *tetanospasmin*, a neurotoxin, and *tetanolysin*, an erythrocytolysin.

Tiberti, whose experiments corroborate those of Meyer and Ransom, found that the toxin is transported to the nerve-centers through the plasma of the nerve-fibers, but that the normal integrity of the axis-cylinders to effect the conduction is preserved. There is, however, a growing school which believes that the toxin of tetanus is not conveyed to the central nervous system by way of the axis-cylinders of the cerebrospinal nerves, but, on the contrary, it is distributed to the ganglion-cells by the lymph-stream.¹ This theory seems to be tenable, particularly because of the splendid results achieved by the introduction of prophylactic doses of antitoxin in the present European War, whereby tetanus has been largely done away with, in spite of severe shell wounds and in spite of the fact that it would be obviously impossible to so inject tetanus antitoxin that it could reach all the nerves in the wound area.

Modes of Infection.—In the outer world tetanus bacilli are found to be both numerous and widely distributed. They abound in the earth (garden-soil in particular), putrefying liquids, manure, in rubbish, and dust of streets and houses, etc. The fact that the bacillus of tetanus is anaërobic explains why it is most apt to follow punctured and contused wounds. An analysis of 1201 cases by Anders and A. C. Morgan affords convincing proof that

¹ Robertson, *Amer. Jour. Med. Sci.*, 1916, clii, 31

every case is the result of the introduction of the tetanus bacillus through a lesion of the skin, however minute it may be, and that so-called idiopathic or "rheumatic" tetanus does not exist. The presence of the bacillus in vaccine has apparently been the cause of some recent cases. The *locality* of the injury is most commonly on the extremities, particularly on the hands and the feet, although the figures of Anders and Morgan (previously cited) indicate the great susceptibility of all portions of the body to the poison.

Certain Predisposing Causes.—(1) Males are more susceptible than females (*e. g.*, out of 981 cases the former sex made up 79.3 per cent.), although males are more exposed to infection. (2) The robust are more receptive than the weak, and the nervous than the lymphatic. (3) Season. In 687 cases the seasonal occurrence was recorded by Morgan and myself and indicated that tetanus is more prevalent in the hotter as compared with the colder months of the year. The maximum number of cases occurred in July (4th of July tetanus). It may be added that as a result of the campaign against 4th of July tetanus there has been a decrease from 104 cases in 1905 to 3 cases in 1914. (4) Age. An analysis of 583 cases, with reference to liability according to age, gave 229 cases, or 39.3 per cent. from the fifth to the fifteenth years of life, 145 cases, or 24.9 per cent. from the fifteenth to the twenty-fifth years, while there were 86 cases, or 14.8 per cent. between twenty-five and thirty-five years. After the fiftieth year only 14 cases occurred.

Immunity.—Horses are rendered immune with increasing doses of tetanus toxin, given over a period of several months. The blood-serum derived from these animals forms the ordinary commercial antitoxin, one unit of which is sufficient to neutralize 1000 fatal doses of toxin for a 350-gm. guinea-pig. The immunity produced by antitoxin injections is powerful, but, unfortunately, persists but eight or ten days.

Clinical History.—The duration of incubation depends upon whether the given case pursues an *acute* or a *chronic* course. In acute tetanus it lasts from one to two weeks, while in chronic the first symptoms usually appear after the second week. In so-called idiopathic tetanus the symptoms appear shortly after exposure to the special causes.

Symptoms of Acute Tetanus.—(1) Mild prodromal symptoms (languor, headache, etc.) may precede the more intense characteristic phenomena, which develop gradually. At first the patient complains of stiffness and tension in the muscles of mastication and back of the neck, and soon tonic spasm of the masseters renders the facial muscles more or less immobile and locks the jaws (*trismus* or *lockjaw*). The rigidity of the cervical muscles is shown by the retraction of, and by attempts at raising, the head. The physiognomy is distinctive; it is immobile, the forehead being often wrinkled and the corners of the mouth retracted, producing a peculiar smile (*sardonic grin*). Next the muscles of the body become rigid, first the trunk (*orthotonos*), and then the spine is bent or bowed and the convexity presents anteriorly (*opisthotonos*). Lateral arching of the body also occurs, though rarely (*pleurothotonos*). The belly muscles are hard and board-like, and their contractions may throw the body forward (*emprosthotonos*). The arms generally remain movable, but the legs may be rigidly extended. The position of the body is one of constant rigidity, but from time to time convulsive seizures of variable duration occur, causing most agonizing suffering, thoracic oppression, dyspnea, and more or less cyanosis, due to interference with the respiratory function (especially spasm of the glottis). Sharp, lancinating pains occur at the base of the chest. "Convulsive dysphagia" (as in hydrophobia) is rarely observed. These spasms are usually reflex. The reflexes are increased. Rostowzew

inks that Kernig's symptom is an early and constant one in tetanus. The intellect remains clear. Profuse perspiration is a significant symptom.

Fever of a moderate degree is generally present. The temperature, however, may suddenly leap to 110° or 112° F. (43.3°–44.4° C.), forming an ominous symptom, these extreme elevations of temperature being probably due to paralysis of the centers that regulate bodily heat. Conversely, fever may be absent throughout the attack, and a brief postmortem rise of temperature be seen. The *pulse* is quickened, and in the worst cases may become very rapid (140 to 160 beats per minute), small, and irregular. The *urine* may be suppressed or its passage impeded by the muscular contractions. The bowels are constipated.

(2) **Chronic Tetanus.**—The same symptoms are manifested as are seen in the acute form, but the condition does not progress so rapidly. In some instances the symptoms soon become aggravated, to be followed, however, by periods of decided relief from the painful spasms, so that during the latter the patient's strength can be maintained by means of stimulating food, and intervals of partial freedom from the excruciating pains grow longer in favorable cases, until finally the period of convalescence may be reached. *Relapses*, however, are common.

(3) **Cephalic tetanus** (first described by Rose) usually follows injuries to the head (face). Its most characteristic symptoms are rigidity of the masseter muscles, spasm of the pharyngeal muscles, causing dysphagia, chronic contraction of the muscles of the neck and abdomen (rare), and paralysis of the facial nerve on the same side as the injury. The latter symptom is due to local infection by a toxin. Recovery takes place in about 25 per cent. of the instances, according to Willard's statistics.

Diagnosis.—In view of the usual history, the predominating feature—trismus—together with the early appearance of rigidity at the back of the neck, will, as a rule, render the diagnosis a simple one.

Strychnin-poisoning must be eliminated (*vide* table):

TETANUS	STRYCHNIN-POISONING
Reception of a wound, generally followed by a period of incubation.	Ingestion of strychnin, followed immediately by the symptoms.
Begins with lockjaw; later spreads downward the arms and hands escaping.	Begins with gastric disturbance or a tetanic contraction of the extremities. Hyperesthesia of the retina occurs and objects look green.
Reflex spasms not present at the outset.	Violent convulsions from the onset.
Rigidity is persistent, except in the chronic form.	Intervals of complete relaxation occur.
The course is prolonged into days or weeks.	Course is brief, terminating in death or recovery.
Cultures made from the discharges of the wound show the <i>Bacillus tetani</i> .	Examination of the gastric contents shows strychnin.

Tetany gives rise to a prolonged spasm affecting the extremities (hands in particular) and the larynx, with intermissions; it is also characterized by a peculiar posture, and occurs chiefly in the young.

Hydrophobia is discriminated from tetanus by the history of a bite from an animal, by the predominance of the reflex spasm of the respiratory apparatus, by the intensity of the psychic disturbance, and by the absence of lockjaw and opisthotonos. The early symptoms are sometimes confused with *rheumatism*, and thus precious time is lost (Voelcker).

Course and Prognosis.—"Acute tetanus or that which developed within ten days gave a total of 568 cases and a mortality of 74 per cent. On the other hand, 211 cases lasted over fifteen days, with only 18 deaths, or

8.5 per cent. mortality" (Anders and Morgan). Chronic tetanus gives a less grave prognosis than does acute. There is a direct relation between the duration of the incubation period and the mortality rate. Death results from asthenia, heart-failure, or asphyxia (during the paroxysm). Pneumonia is common as a complication and may prove to be the cause of death. According to Richter's statistics, 88 per cent. of military cases are fatal. In the so-called idiopathic cases the mortality rate is under 50 per cent. In the newborn recovery is quite exceptional.

Treatment.—On account of the frequency of tetanus in the early years of the war and on account of the large amount of experimental work that has been recently done in this disease the methods of treatment and prophylaxis have been so standardized that the results achieved from present-day treatment as contrasted with those of the earlier period of antitetanic serum are in no way comparable. The methods as universally employed consist first in the injection of 1500 units of antitoxin into or around the principal nerve supplying the region of the wound and above it. Robertson¹ states that in the large majority of cases the subcutaneous injection of 20 units of antitoxin *immediately* after the injury will prevent with certainty the occurrence of tetanus. The same author and Aschoff² recommend soaking in absorbent cotton and drying. When this cotton is applied to the wound the moisture of the tissues liberates the antitoxin. The prophylactic injection should be repeated in ten or twelve days if the wound is not healed. The treatment of the wound itself consists usually in opening and draining. Antiseptics, as tincture of iodine, may be used to wash out the wound if not too extensive. A puncture wound is swabbed out with 95 per cent. phenol, followed by alcohol. Extensive wounds, as shell wounds, are best treated by the Carrel method, that is, more or less continuous irrigation of the wound with Dakin's solution until pus disappears. Dakin's solution is made by adding to 140 gm. of anhydrous sodium carbonate in 10 liters of water, 200 gm. of chlorinated lime. A precipitate forms which is filtered off. To the filtrate is added sufficient boric acid, 30 to 40 gm., to make the solution faintly acid. If the symptoms of tetanus appear in spite of prophylactic treatment or if none has been used because of the failure to suspect or to see a wound, then certain definite steps as pointed out by Ashhurst and John and amplified by Park are indicated. The wound itself is not touched unless it clearly requires opening and draining. In such cases it is advisable to infiltrate the surrounding tissues with antitoxin. Taylor³ states that the early débridement of the wound is as important a prophylactic measure as is the administration of serum. The remainder of the treatment is best summarized by quoting Park's method of giving antitoxin as recommended by the New York City Board of Health:

(1) From 3000 to 5000 units into the lumbar region of the spinal canal, preferably under an anesthetic, the volume of fluid injected being brought up to 10 or 15 c.c. by the addition of sterile normal saline, the exact amount being regulated according to the age of the patient and the amount of spinal fluid withdrawn.

(2) Ten thousand units intravenously at the same time.

(3) Repetition of the intraspinal dose in twenty-four hours and forty-eight hours to replace that removed by absorption from the spinal canal and delivered to the blood.

(4) A subcutaneous dose of 10,000 units four days later to keep up the antitoxic strength of the blood.

¹ *Jour. Med. Assoc.*, March 25, 1916, p. 931

² *Jour. Amer. Med. Assoc.*, 1915, lxxv, 748.

³ *Ibid.*, March 9, 1918, p. 681.

Bazy thinks that the recent war has taught us that the only method sufficient and free from all criticism is the subcutaneous route.

Magnesium sulphate may be used to control the convulsions, and when antitoxin cannot be secured it is the best method of treatment now known.

Meltzer¹ states that the best general plan for the treatment of tetanus is as follows: "In each and every case of tetanus 1.2 c.c. of a 25 per cent. solution of magnesium sulphate should be given by subcutaneous injection three or four times a day throughout the entire disease. When the disease is complicated by severe tetanic attacks 1 c.c. of a 25 per cent. solution for every 10 kg. (20 pounds) body weight (in adults) should be given by the intraspinal method. When the disease is attended by immediately dangerous tetanic complications from 2 to 3 c.c. per minute of a 6 per cent. solution of magnesium salts should be given then by an intravenous injection until dangerous symptoms subside or the respiration becomes shallow or too slow.

"When the respiration seems to become impaired in consequence of the administration of magnesium salt by the intravenous, intramuscular, or subcutaneous methods, calcium chlorid should be injected in the manner described above.

"It is advisable to have at hand an apparatus of intrapharyngeal insufflation ready for use whenever the respiration becomes slow or shallow. Finally, the simultaneous treatment by antitetanic serum should not be neglected." Leyva² states that sodium persulphate combined with the antitetanic serum relieves the pains and spasmodic attacks. The minimum dose must be 60 c.c. in one day and the solution must be freshly prepared and kept in a cold, shaded place, as light and heat decompose it.

MALTA FEVER

(*Mediterranean Fever; Rock Fever; Undulant Fever*)

Definition.—A protracted infectious disease caused by the *Micrococcus melitensis*, and characterized clinically by irregular fever, copious sweats, rheumatoid pains, and frequent relapses.

History.—Malta fever was described clinically by Burnett in 1816 as a type of remittent malarial fever, but it was first depicted as a specific disease by Marston in 1859. It is *endemic* in Malta, and from time to time is encountered there and at other Mediterranean ports in *epidemic* form. Owing to observations made by Wright on the serum reaction this disease has been shown to exist in India, Hong Kong, the United States, the West Indies, and Brazil. Kinyoun first suspected the presence of malta fever on this side of the Atlantic along the coast and in the islands of the Gulf of Mexico. Musser and Sailer recognized the affection in Philadelphia in a soldier who had come from Porto Rico. The disease has recently spread to various parts of Spain and France. No essential *pathologic lesions* have been identified with the disease. Hughes noted an enlargement of the spleen and of the mesenteric glands, and in grave cases, bronchitis and bronchopneumonia.

Etiology.—**Bacteriology.**—The *Micrococcus melitensis* (Bruce) has been found in certain tissues (the spleen in all fatal cases), and is readily recognized morphologically and by culture. Bruce, in 2 cases, and Hughes, in 4, re-

¹ *Jour. Amer. Med. Assoc.*, March 25, 1916, p. 931.

² *Surg., Gyn., and Obst.*, December, 1917, p. 613.

produced the disease in monkeys by the inoculation of pure cultures of the organism. Antihygienic conditions increase morbidity. There is no special liability according to age. Goat-herders are markedly predisposed.

Modes of Infection.—(a) By the “absorption of urine secreted by cases of Mediterranean fever, and this is one way in which workers in hospitals become infected” (Horrocks). (b) It is probable, though not proved, that human beings are infected by the bites of infected mosquitos—*Culex pipiens*, *Stegomyia fasciata*. (c) By the absorption of infected goats’ milk from the alimentary canal. Gentry and Ferenbaugh have obtained the positive serum test in 34 per cent. of the goats examined.

Pathology.—There is no special pathology. The postmortem shows such changes as are incident to high fever and infection.

The incubation period lasts from six to fourteen or sixteen days.

Symptoms.—The disease is of *slow* and *gradual* development, and the features simulate those of beginning typhoid fever. Headache, boneache, anorexia, malaise, and slight fever (often preceded by shiverings); the face may be congested and epistaxis may be present. The bowels are constipated and the stools may be blood-streaked. The spleen is always enlarged and frequently painful, particularly on pressure.

Three classes of cases are recognized: (1) A *pernicious* type which is rare and generally fatal (Hughes) and needs no further description here; (2) an *undulant* type, characterized by exacerbations of temperature at pretty regular intervals; (3) a *continued* type, in which a continuous fever persists for weeks and even months. The *fever* is of a remittent type, with undulating course, and perspirations lasting one, two, or three weeks; this, after an apyrexial period of two or three days, is followed by a relapse, with rigors, high fever, delirium, and increased prostration.

The *relapse* frequently lasts from five to six weeks, and then, after a week or two, a second relapse may ensue; symptoms somewhat similar to the first—rigors, intermittent form of fever, extreme prostration, and general rheumatoid symptoms. The latter may be so well marked as to prohibit muscular movements of any kind. The case now either terminates in recovery or, after the lapse of one or even two months, there may be a repetition of the whole symptom-complex. In *grave cases* the temperature is continuous and death may occur in hyperpyrexia (Hughes). The temperature range is often markedly irregular, hence its comparative uselessness, as claimed by Craig, from a diagnostic point of view. A polynuclear leukocytosis is present in Malta fever. Certain *complications*, as touches of pleurisy and pneumonia, rarely appear.

Diagnosis.—Pure cultures of the special organism give a typical agglutination reaction in the blood-serum of Malta fever patients, which may persist for two or more years after the subsidence of symptoms. Thus the affection is with ease and certainty distinguished from *typhoid fever* and erratic forms of *malaria*. In no other manner can it be discriminated from typhoid fever in the earlier stages. If *malaria* is suspected, the blood should be examined microscopically. Many cases present hacking cough and physical signs of lung congestion, or even consolidation, and, as a consequence, are confounded with *incipient tuberculosis*. The serum test will remove all doubt. Malta fever not infrequently, in its mode of onset and the symptoms present during the first few days, resembles *lobar pneumonia* (Craig). The absence of rusty sputum, stabbing chest pains, and the milder character of the cases however, are an aid in excluding pneumonia. The polyarthritides with fever has led to confusion with *acute articular rheumatism*. *Pyemia* must also be excluded. A para-undulant fever due to a *Micrococcus para-melitensis* is now recognized.

Duration and Prognosis.—Soldiers show an average stay in the hospital of ninety days (Bruce); obstinate cases, however, may last six months. Most cases pursue a chronic course. The death-rate is low—about 2 per cent. Death is generally due to hyperpyrexia.

Treatment.—This should be sustentative or supportive, in view of the uncertain, protracted course. Nourishing liquids and, usually, stimulants are required. Dalton allows solids, such as eggs, rice, and bread, in addition to 2 to 3 quarts of milk. The bowels should be moved daily. Fever is to be combated by the application of cold (cold bath, wet pack, or sponging). Methylene-blue (gr. $\frac{1}{4}$ —0.05, two or three times daily) is considered the best remedy available (Audibert and Rouslacroix). Bassett-Smith reports two series of cases treated with vaccine prepared from cultures of *Micrococcus melitensis*, freshly isolated from the spleen during life, with gratifying results. Tonics, coupled with a change of climate, favor convalescence. Hematinics are especially indicated during this period to overcome the well-marked secondary anemia.

RAT-BITE FEVER

Definition.—Rat-bite fever is an infectious disease following the bite of a rat or, much more rarely, the bite of some animal having contact with rats (weasel, ferret, cat).

Etiology.—In 1914 Schottmüller first described a streptothrix (*Streptothrix muris ratti*). More recently Blake has isolated an organism practically identical, which he obtained from the blood during life. The organism is a branching, filamentous one with tendency to fragment into bacillus-like and coccus-like forms. These stain readily with the usual bacterial stains and are negative or faintly Gram-positive. Tileston independently discovered thread-like organisms in the blood of a typical case during the febrile paroxysms. R. Row has demonstrated a specific spirochete in the lesions, but this observation needs confirmation.

Symptoms and Diagnosis.—The incubation period ranges from one to sixty days, averaging about two weeks. This is followed by one or more febrile attacks, accompanied by a characteristic rash. As a rule there are many of these paroxysms, which tend to recur with remarkable regularity at intervals of from five to ten days. The duration of the individual attack averages from two to three days. The temperature rises gradually, to attain the maximum on the second day, and falls by crisis, with profuse sweating. Severe muscular pains and dysphagia are often prominent symptoms. In the interval between attacks the patient feels almost well.

The exanthem consists of a few large spots, “varying in size from that of a dime to that of the palm of a hand, slightly raised or flat circular spots. The lesions are bluish-red in color; erythematous rather than urticarial.” The eruption is usually generalized, although it may be confined to the neighborhood of the wound. The average duration of the disease is about two months.

Among unusual types occur the following groups: (a) afebrile type, (b) continuous, and (c) miscellaneous types.

The *prognosis* is fairly good, the death-rate being about 10 per cent. The *treatment* is both prophylactic and medicinal. Miyake advocated early cauterization with phenol, and since utilizing this method has not seen the development of the clinical picture.

Hata employed salvarsan in a series of cases from Japan, with remarkable results. Usually a single intravenous injection sufficed to bring about a cure. D'Halluin and Fievez report a case occurring in a woman of forty-nine who had been bitten on a finger by a rat, the glands in the axilla and above the clavicle becoming enlarged, with attacks of fever recurring during six months, with neurasthenia and loss of appetite. Under hypodermic medication (*sérum néurasthénique*) and 0.005 gm. sodium arsenate by the mouth, daily, the symptoms gradually subsided.

TRENCH FEVER

(*Five-day Fever; Febris Wolhynica*)

Trench fever was first recognized by His in the German Army, and called by him Wolhynian fever. Shortly after this cases were recognized in the British Army in the winter of 1916, and it soon became apparent that this was the same condition about which His was writing. About the same time cases of trench fever were reported from Salonika and Mesopotamia. With the recognition of this affection the following facts appear to be well established: (a) It was widely prevalent in the British and French Armies, and to a lesser extent in the American Armies (Swift). (b) The virus causing trench fever is present in the blood and apparently has been cultivated by appropriate bacteriologic methods. However, it is still an open question as to the cause of trench fever. For example, Arkwright¹ was unable to confirm any of the experimental results by other investigators on the bacteriology of this condition, and he has very definitely denied the claims of Bradford, Bashford, and Wilson, who believe they have isolated a definite organism. Strong states that 103 experiments on human volunteers have absolutely established trench fever as a specific infectious disease caused by filterable virus transmitted by the bite of the louse and which is present in the urine of those sick with the disease. It can be passed through the Chamberland filter and is killed by heat at 60° C. Homer Swift says it undoubtedly belongs to the group of filterable viruses. (c) The period of incubation determined by subcutaneous injection of the blood taken from patients during the active stage of the disease is from six to twenty-two days. (d) Transmission of the condition is probably through the louse, which may transmit the disease either through biting or by deposition of feces on the skin of the infected men, which is subsequently scratched into the skin, according to the report of the American Trench Fever Commission.

Symptoms and Clinical Course.—The course is extremely irregular as a rule. The British Expeditionary Force Trench Fever Commission classify the types as follows: (a) Relapsing, either regular or irregular. (b) One single large bout resembling influenza. (c) Continuous fever extending over a longer period, resembling in its form typhoid or paratyphoid fever.

The onset may be acute, with headache, dizziness, and muscle and joint pains, frequently nocturnal, and appearing, as the British have pointed out, chiefly in the muscles of the legs, more especially at the point of their insertion in the bones (shin pains). In certain other cases there is no acute outbreak, but the symptoms come on insidiously. The symptoms may disappear entirely for a long period; again, the period of latency may be short, as in malaria. In some patients the disorder tends to become subacute or chronic, with the appearance of neurasthenic symptoms, and more particularly cardiac neuroses,

¹ *Brit. Med. Jour.*, Aug. 23, 1919, p. 233.

such as are seen in disordered action of the heart. Physical examination discloses very little except an enlarged spleen, and laboratory examination may show either a leukopenia or a moderate leukocytosis, the latter being most frequent. The urine shows the usual febrile reaction.

Diagnosis.—Swift,¹ in discussing this phase of the disorder, says that the sudden onset resembles that of any acute infection; the “pink eye” suggests influenza; the enlarged spleen, malaria or typhoid; the rash resembles the rose spots of typhoid; the neck pains are like those of meningitis; the back pains suggest lumbago; the joint and muscle pains, chronic rheumatism or myalgia, and the characteristic shin pains, dengue. Relapsing fever must also be considered in many cases as the causative factor in producing a fever curve and symptoms resembling this disease. Any of these various diseases may have to be excluded before the diagnosis is reached, and most of them will have to be excluded by the negative laboratory findings.

Prognosis and Treatment.—The disease is not fatal, but the aftermath is frequently annoying and disturbing. Various neuroses, disordered action of the heart, chronic muscular pains, etc., may persist for some weeks or months.

Treatment is wholly symptomatic. Prophylaxis consists of preventing lousiness, an utter impossibility when troops are engaged in active campaigning.

PROBABLE INFECTIOUS DISEASES

MUSCULAR RHEUMATISM

(*Myalgia; Fibrositis*)

Definition.—A common, painful disease of the muscles and of the structures to which they are attached (fasciæ and periosteum). Leube contends—and very properly, I think—that muscular rheumatism is a general disease with local symptoms. The latter may be seated in different parts of the body, and in this way rise to a number of leading subvarieties, and it may either accompany acute and chronic rheumatism or it may be experienced as an independent disease. I have also met with several instances in which it followed joint rheumatism, and Leube has seen it precede the latter. Certain authors believe that the affection is a neuralgia of the sensory nerves of the muscles.

Pathology.—In fatal cases (these are exceedingly rare) the affected muscles show a swelling of the fibers and more or less granular change. In long-standing cases there is an atrophy of the muscles due to trophic disturbance. Strauss describes circumscribed nodules in the muscles.

The changes are essentially those of myositis. In the acute form there is often an extensive round-cell infiltration of the connective tissue, with swelling and partial degeneration of the muscular fibers and the formation in them of vacuoles. In the chronic form there is a proliferation of the interfascicular connective tissue.

Etiology.—Among the disposing influences the most important are: (1) The *rheumatic diathesis* (appropriate soil); (2) *heredity*; (3) *exposure* to cold, damp, and strong air-currents, especially after heavy exercise or during free perspiration; (4) *sex*, owing to the more frequent exposure of men while following their occupations; (5) *age*. It is met with at all ages, but acute and subacute forms most frequently occur among children and young adults,

¹ *Jour. Amer. Med. Assoc.*, 1919, lxxiii, 807.

of fever does not exclude the affection. It differs from *neuralgia* in that there are no painful points, and in that firm pressure with the broad hand often affords relief. On the other hand, in *gonorrheal rheumatism* the plantar fasciæ are commonly involved and the patient complains of pain in the head. *Dermatomyositis* must not be confounded with muscular rheumatism. Unverricht first distinguished the former from the latter, showing that there are present pain and swelling of the muscles, as in muscular rheumatism, but additionally redness (erythema) and hyperesthesia of the skin, while the joints usually escape. Of general symptoms, the chief are fever and physical prostration. The spleen is enlarged, and angina and hemorrhages have been noted. The disease is obviously infectious, probably septic in nature, and may rarely prove fatal. Dermatomyositis, unlike muscular rheumatism, is more common among women, especially servants, than men. *Abdominal rheumatism* has been mistaken for appendicitis.

The **prognosis** is good, the disease never endangering life, though a person may be incapacitated for work by muscular rheumatism.

Treatment.—Severe and acute forms demand the use of opiates internally and anodyne and hot applications externally. When cases are seen early, morphin, administered hypodermically, may serve to relieve the pain and cut short the disease. In acute cases the salicylates and other antirheumatic remedies are to be employed. Hot fomentations give comfort, and the Turkish bath may end the attack if it can be used sufficiently early. The hot-water bag, sponging with water as hot as can be borne, or dry heat in the form of bags filled with heated salt or heated hops, will all do good service. For the dull pain which is so distressing in some cases of torticollis the affected muscles may be covered with flannel, over which a warmed flat-iron may be passed for a few minutes. This is an efficient expedient. For lumbago acupuncture is highly commended. Needles of from 3 to 4 inches (7.5–10 cm.) in length (ordinary bonnet-needles, sterilized, will do) are thrust into the lumbar muscles at the seat of the pain and withdrawn after five or ten minutes (Osler). Schmidt recommends local injection of 5 or 10 c.c. of physiologic salt solution for the relief of pain. Blisters have been recommended, but I have tried them without beneficial effects. In subacute and obstinate cases I have recently obtained good results from the use of a 20 per cent. ointment of salicylic acid freely rubbed into the skin. Active friction with anodyne and stimulating liniments (the latter when pain is not great) is worthy of trial. Dry cups, massage, and electricity (constant current) are sometimes efficient, and in chronic cases potassium iodid, guaiacum, and arsenic (the latter in small doses) should be tried. Rowntree and Baetjer report 59 cases of muscular rheumatism treated by radium, of which 49 were either cured or improved. The same measures of prophylaxis are to be adopted as in chronic rheumatism. The general health must also be looked to, every endeavor being made to maintain the proper quality of blood and perfect nutrition.

MOUNTAIN FEVER

(*Mountain Sickness*)

The term "mountain fever" should be regarded as applicable only to a condition produced by the action of a rarefied air upon the organic functions. There is no definite *pathology*. Aron's investigations show that the intake of oxygen is diminished at high altitude.

The **symptoms** are a much-quickenened pulse, urgent dyspnea, headache, vertigo, and at times nausea and vomiting. There is a subfebrile movement, the temperature touching 100° F. (37.7° C.) or even 101° F. (38.3° C.).

Thirst is present and the appetite is lost. Malaise and a sense of exhaustion on attempting exertion are experienced. Hemoptysis has been noted, but rarely. The effect upon the human economy of high altitude varies with the extent of the differences in individual reserve nerve force. Rest and acclimatization will almost invariably restore healthy function. Oxygen inhalations are advised (Aron).

The mountain fever of the older writers is almost universally conceded at the present day to be typhoid fever modified by the effects of extreme altitude.

FEBRICULA

(*Simple Continued Fever; Ephemeral Fever*)

Definition.—A brief febrile attack, unattended with definite local lesions, and of varied, often indeterminate etiology. A true ephemeral fever is one that lasts about twenty-four hours, while the term “simple continued fever” or “febricula” is given to cases lasting a longer period.

The cases are diversified with reference to their etiology and clinical relations, but may be roughly grouped under several heads:

(a) A large group of cases in which a *gastro-intestinal disturbance* is the only assignable cause. The latter may be due to cold or, more often, to errors in diet (particularly the use of tainted food-stuffs), accompanied by absorption of ptomains, or it may assume the form of gastro-intestinal catarrh met with in young children.

(b) Undeveloped or abortive forms of the *infectious diseases* (typhoid, influenza, rheumatism). These affections, particularly during times of epidemic prevalence, may run a brief course without manifesting any of their distinctive characters. This is particularly true of the abortive types of typhoid and other acute infections. Again, diseases that ordinarily manifest a characteristic eruption (*e. g.*, scarlet fever, measles, erysipelas) may run their course without doing so, or the eruption may escape observation.

(c) It may follow *exposure* to the summer sun or *excessive heat* (?), or *exhaustion of the nervous system*.

(d) It is not infrequently the result of a slight and unnoticed *localized inflammation* (tonsillitis, bronchitis, lymphadenitis, etc.).

(e) The *inhalation of sewer-gas or other noxious vapors* (such as emanations from decomposing organic matter) may produce an aberrant form of the fever (*vide* Septicemia).

Symptoms.—It is to be remembered at the outset that a single symptom, peculiar to all cases, is the *fever*. The *onset* is generally sudden, and especially in ephemeral fever, but it may be gradual; if sudden, there is rarely either a chill or vomiting, while in neurotic children a convulsion may occur. The temperature ascends quickly to 102°, 103° F. (38.8°–39.4° C.), or over, pursues the continued type, and at the end of one, two, or more days subsides abruptly by crisis. There are accompanying symptoms, many of which are due to the fever, such as headache, hebetude, mild delirium, flushed countenance, a full, rapid pulse, anorexia, constipation, scanty, high-colored urine, and, not rarely, herpes labialis. Defervescence may be attended with critical sweats, diarrhea, or a copious flow of urine. *Special types* (*e. g.*, cerebral, gastric, gastro-intestinal) may be observed, due to the predominance of the symptoms presented by individual organs or systems.

In another class of cases the access of simple fever may be less sudden, the maximum level attained being somewhat lower and the attending phenomena less acute and pronounced. Da Costa has described cases belonging to

is category. The *course* is more protracted, though rarely exceeding a week or ten days, and the defervescence is not so abrupt. So-called *thermic fever* at the present writing believed by Guitéras, who first described it, to be due to a special, though as yet unknown, organism.

The **diagnosis** necessitates the exclusion of other acute fevers. The affections from which it is most difficult to distinguish febricula are *typhoid fever*, *remittent fever*, *scarlet fever*, *incipient tuberculosis*, *larval pneumonia*, and *meningitis* (in children). In febricula, however, there is an absence of local manifestations and of physical signs pointing to consolidation of the lungs; characteristic skin eruptions are also absent. Tyson points out that in cases in which there is splenic enlargement (rare) the resemblance to typhoid is close, and the diagnosis may have to remain in doubt until settled by the Widal test or by time. The cases must also be discriminated from the fever which sometimes attends chlorosis and certain nervous disorders.

The **prognosis** is good.

Treatment.—Few cases require treatment other than rest in bed and liquid nourishment for several days. Cooling drafts internally, and mild forms of hydrotherapy (spongings, ice-caps) externally, are indicated. If traceable to gastro-intestinal disturbance, a laxative usually proves beneficial and effective. It should be followed by intestinal antiseptics. Unless it is clear that the given case is non-infectious and non-contagious, isolation of the patient should be ensured.

MILK-SICKNESS

Definition.—A peculiar infectious disease occurring both in man and in the lower animals, when it is known as “trembles.” The disease is unknown east of the Alleghany Mountains, but throughout many of the Western and Southwestern States it formerly prevailed very extensively, with fatal effect. It has, however, been almost exterminated as the result of denudation of the forests and the advancing cultivation of the virgin soil. It still prevails in parts of North Carolina (Osler), and until very recent times has been seen in certain parts of Illinois.

No peculiar pathologic lesions have been described.

Etiology.—It is believed to be due to a special poison derived from the earth, but as yet we are ignorant of its exact nature. Phillips claims to have found a spirillum in the blood.

Modes of Infection.—The disease attacks cattle most frequently (especially unweaned calves), horses, sheep, goats, and less often many undomesticated animals; wherever “trembles” prevails among cattle, milk-sickness is met with in man. It is thought that the poison is communicated to man in the milk, butter, and cheese, or in the flesh of infected animals.

Among disposing factors are the *seasons*, the disease being most frequent in the late summer and autumn. It is most common in adult life.

Symptoms.—The period of *incubation* may be short or long in duration, and *prodromata*, such as headache, anorexia, languor, and oncoming fatigue, may be noted. These symptoms increase in severity, and are soon eclipsed by the more characteristic features—nausea and vomiting, a hot pain in the stomach, and a peculiar fetor of the breath. There is an unquenchable thirst, a swollen, tremulous tongue, and absolute constipation. Fever is present, but it is slight, and the surface temperature is often below the normal. The nervous symptoms include restlessness, merging into mental dulness with marked indifference, the latter condition passing in grave cases into a stupor that may deepen into actual coma. Convulsions may arise or the patient may drop into a fatal typhoid state.

emaciation. Though a disease of mild character, its territorial range is so vast as to entail untold loss to European countries. Young animals or sucklings perish in great numbers on account of the deteriorated quality of the milk, which assumes a yellowish-white appearance and has a bitter, nauseating taste.

During epidemics of foot-and-mouth disease the poison may be transferred to man, in whom the disease is known as *epidemic stomatitis*, the poison generally being transferred by means of milk. Boiling the latter destroys the virus, but rarely the infection may be transmitted through butter and cheese made from the milk of infected cattle. Communication by inoculation (while milking) may also occur. The disease does not seem to be transmissible through the meat of diseased animals.¹ In America a few instances only of transference from animals to man are recorded.

Symptoms.—The *incubation period* lasts from three to five days. A rigor may mark the onset, or merely slight shiverings, followed by fever and malaise, and soon vesicles, such as are described under Aphthous Stomatitis, appear upon the tongue and inner surface of the lips. The mouth is hot, the mucosa reddened and swollen, and salivation is present. A form of miliary eruption that may become pustular may also appear on the skin surface, and particularly on the fingers and hands. Hemorrhages have been observed in severe epidemics.

The **diagnosis** is made with ease if the disease be prevailing at the same time among lower animals. The peculiar coincidence of the eruption in the mouth and extremities, sparing the rest of the body, has not been noticed in any other eruptive disease (Whittaker).

Course and Prognosis.—The course is mild and ends in about one week, the disease being very rarely fatal.

Treatment.—*Prophylaxis* requires the use of milk from healthy animals (cows or goats), together with measures looking to the care of the stables and isolation of diseased cattle. A reliable method of immunization against foot-and-mouth disease has not as yet been discovered. For *treatment* the reader is referred to the article on Aphthous Stomatitis.

GLANDULAR FEVER

Definition.—By this term is meant an acute infectious disease of children characterized by adenitis affecting the lymph-glands of the neck, especially the anterior cervical.

History.—A detailed description of glandular fever was first given by E. Pfeiffer, in 1889, under the name of *Drüsenfieber*, but it had probably been previously described by Filatow, of Moscow. Donkin, Fischer, and Dawson Williams, in England, and J. Park West have given excellent descriptions of the disease.

Pathology.—The anterior cervical lymphatic glands are involved first, and it is "probable that the infection finds its point of entrance through either the tonsils or the pharyngeal mucous membrane" (Williams). The adenitis may also affect the inguinal and axillary glands.

Etiology.—The special micro-organism of the disease is unknown, although Burns has isolated the *Staphylococcus aureus*. The complaint occurs usually in the form of house epidemics. West, of Ohio, however, has described the most wide-spread epidemic hitherto recorded. There were 96 cases in 43 families, and rarely did a child exposed to the infection escape. The disease usually occurs during childhood; the ages of West's cases ranging from seven

¹ Zuell's translation of Friedberger and Fröhner's "Pathology and Therapeutics of the Domestic Animals."

the ray form of growth. Individual growths are of the size of a millet-seed, but their aggregation may result in masses as large as an orange; they are of a sulphur-yellow color and of tallowy consistence. Induration and infiltration may extend far into the surrounding tissues.

Microscopically, the little or single ray-like tumors show straight or wavy branching filaments (*supra*). Their development is accompanied by the growth of dense adjacent connective tissue. In addition, abscesses containing yellow granules in the pus occur, but these are secondary. In man the lesions consist of nodular growths with secondary abscess formation, differing from those described as occurring in beasts.

Bacteriology.—The organism of the disease belongs to the cladothrix variety of fungus, and may be cultivated, though with difficulty. The finer threads may readily be stained with anilin colors. The club-shaped projections, however, do not take these stains. Pus from whatever source should be examined for the actinomyces even though cocci are present. Rabbits and cows have been successfully inoculated. Pyogenic organisms are commonly in association.

Modes of Infection.—Infection generally takes place in young subjects through the mouth, teeth, and pharynx; and rarely the infection atrium is the air-passages or the skin. Cope thinks the organism enters most often through the mucosa of the alveolar margin near a carious or erupting tooth, or through the tooth-socket into the jaw. The infecting microbe is generally introduced with the food or drink, and Bostroem, from a study of 32 cases, concludes that the poison enters the economy by means of the ingested grains of some cereal (barley).

Clinical History.—(1) ORAL ACTINOMYCOSIS.—The patient often complains of *toothache*, *dysphagia*, and of *difficulty in opening the jaw*. The latter symptom may be owing to induration of adjacent muscles, and is a very characteristic sign (Partsch). At the angle of the jaw a swelling appears, which quickly passes into suppuration; later it opens (first externally, then into the mouth) and discharges pus containing little yellow masses. If not properly treated, extension of the process takes place in a downward direction, even to the abdominal organs.

The *upper jaw* may be the primary seat of infection, and if so the base of the skull may be perforated and the disease attack the meninges and brain. Bollinger has seen primary actinomycosis of the brain. In these instances caries of the spine may result from extension.

(2) PULMONARY ACTINOMYCOSIS.—I am satisfied that primary pulmonary actinomycosis is comparatively rare, although Karewski and Butler have each recently reported an instance. In Butler's cases the disease followed an injury by a falling board. The disease begins with *pain in the side*, often the left, due to *pleurisy*. There are *cough* and a peculiar (fetid) *expectoration*, together with general wasting. A microscopic examination of the sputum, if made with care, reveals the *actinomyces*. In some instances the symptoms are identical with those of *disseminated tuberculosis* of the lungs (Brigidi), though generally the disease is unilateral. There is irregular fever due to suppuration.

The **physical signs** may be those of chronic bronchitis merely; but there are, in not a few cases, extensive destructive changes of variable character (abscess, bronchopneumonia, etc.), which modify the signs accordingly. In primary pulmonary actinomycosis an extension to adjacent organs and also metastatic growths and abscesses occur. Wood and Eshner found the so-called sulphur granules in a pleural exudate.

the skin reactions may be obtained by means of concentrated glycerinated ton cultures of streptotrichins. The tubercle bacillus is absent from the sm in cases of pulmonary streptothricosis, but streptococci and staphylococci are found in association, and some of the cases may be of primary streptococcal infection. Streptothricosis may be confused also with actinomycosis, but in cases with multiple abscesses in the subcutaneous tissues, glanders may be simulated.

Magalhães has discovered a new mycosis which bears a close resemblance to pulmonary tuberculosis and is caused by the Brazilian oïdium. The tubercle bacillus is absent, and if doubt remains, potassium iodid or sodium iodid administered causes the condition to retrogress and finally to disappear.

The disease is feebly communicable by contact. According to Lynch,¹ "the rat is a possible and probable disseminator of dysenteric amebæ pathogenic for man."

Pathology.—The lesions are almost always situated in the large intestine, although rarely the ileum is also invaded. The first visible change is a hyperemia of the mucosa, most marked in the descending colon and rectum; but the changes which produce the characteristic dysenteric ulcer begin with infiltration and swelling of the submucosa, followed by necrosis, which involves the overlying mucosa with its epithelium (Kruse and Pasquale). How the amebæ reach the submucosa has not yet been observed. The infiltrated circumscribed areas are oval or hemispheric in shape, and project above the level of the surrounding mucosa. The submucosa presents a grayish-yellow appearance, and is soon thrown off in the form of a slough.

The ulcers take various shapes—chiefly irregular, and less frequently round or oval. Their edges are ragged and undermined, and the floor, which is more or less covered with pultaceous material, is rough or crater-like, and formed by the musculature or the outer serous coat of the intestine. From the manner in which the ulcers are formed it is obvious that cellular infiltration (followed by necrosis) may occupy the submucosa for a greater or less distance beyond the borders of the ulcers. In this way fistulous channels may be produced beneath the mucosa and connect two or more ulcers. Usually this ulcerative process affects only certain portions of the large gut, especially the flexures—hepatic and sigmoid—and the rectum; but it may be general, and I have seen an instance of this kind. Cases are not uncommon in which the ulcers are so numerous as to include almost the entire mucosa of the colon.

Healing is attended with the development of fibrous tissue along the edges and in the base of the ulcer, and secondary contraction of this new connective tissue is often productive of colonic stricture, which is usually either partial or irregular. The cases that come to autopsy often show diphtheritic inflammation as a secondary or terminal condition.

The *microscope* reveals proliferation of the fixed connective-tissue cells (rarely pus), and the presence of amebæ in the walls and the base of the ulcers, in the lymph-spaces, and rarely in the blood-vessels.

The *liver* may be the seat of prominent lesions. These are: (a) *abscesses*, which may be single or multiple. The single or large solitary abscess is usually situated near either the upper convex or the lower concave surface, while the abscess cavity is formed in a manner similar to the intestinal ulcers. The area affected is at first infiltrated; it then becomes necrotic, and finally more or less liquefied. Upon the full development of the first stage the part invaded is a grayish-yellow pultaceous mass, but in the second or necrotic stage the abscess contains a yellowish or greenish-yellow spongy material with beginning liquefaction. The contents of the mature abscess consist of a greenish- or reddish-yellow purulent material and of remnants of liver tissue. The walls of the recent abscess are irregular and ragged, those of an old abscess being dense and fibrous, and a section of the abscess wall shows an inner necrotic zone, a middle zone (in which there is great proliferation of the connective-tissue cells, compression and atrophy of the liver-cells), and an outer zone of intense hyperemia (Osler). The contents of the abscess show either few or many amebæ, and only rarely pus. When pus is present it is due to a secondary infection by the pyogenic germs. The amebæ probably gain access to the liver by metastasis from the intestinal foci. Cultures are generally sterile.

(b) The parenchyma of the liver may be the seat of circumscribed necrotic spots, due to the action of the toxins formed by the amebæ.

¹ *Jour. Amer. Med. Assoc.*, December 25, 1915.

The lungs sometimes show changes similar to those in the liver; they are the result of direct extension of the hepatic abscess through the diaphragm into the lower lobe of the right lung. The kidneys often present the lesions of acute parenchymatous nephritis (Craig).

Clinical History.—The mode of *onset* is *gradual* except in a small proportion of the cases, in which it is sudden, with well-marked symptoms. When, as generally happens, it is insidious, the initial symptom is often a trivial diarrhea. The affection is then characterized principally by *intermissions* and an exacerbating *diarrhea*, the liquid stools containing necrotic tissue of a grayish-brown and sometimes yellowish-gray color. The latter are often bloody and mucoid, later becoming fluid. The *number* of discharges per day is exceedingly variable, although in most instances they range from six to eight or ten daily.

Microscopic examination of the feces during the exacerbations discloses amebæ that are almost invariably endowed with motion, though usually not when the stools have become formed. Tenesmus is not a prominent feature in most cases, and may be entirely absent. Colicky abdominal pains, nausea, and vomiting are rare.

General Symptoms.—Fever is usually present, but it is slight and exhibits marked variations. In certain instances, however, the temperature is below the normal. From the time of onset there is gradual, progressive loss of flesh and strength, and anemia becomes well marked.

Complications.—The most common is *hepatic abscess*, and as the result of perforation of the diaphragm secondary abscess of the right lung may arise. Authors are not agreed as to the frequency of occurrence of liver abscess (see p. 882) in amebic dysentery, but it is certainly comparatively rare in this country, not exceeding, perhaps, 3 per cent. of the cases. In the tropics it occurs in 20 to 25 per cent. of the cases. *Peritonitis* may result from perforation of a dysenteric ulcer, causing death. The point of perforation may, however, be in the rectum, when *periproctitis* is the result; or it may be in the cecum, when *perityphlitis* is the sequel. In tropical or subtropical countries the disease is often complicated with malaria. The presence of an intermittent fever is not, however, sufficient to warrant the assumption that malaria complicates dysentery; we must be able to demonstrate the presence in the blood of the *Plasmodium malariae*. In pyemia and in suppurative processes generally—conditions sometimes met with in dysentery—the temperature-curve is often distinctly intermittent. *Typhoid fever* is a rare complication. The *typhoid state* is met with, and pyemia and septicopyemia may appear late. Pylephlebitis, pericarditis, pleuritis, and nephritis (common) are observed. Moorhead¹ describes dysenteric arthritis occurring in persons giving a history of amebic infection.

Diagnosis.—The slow course, marked by intermissions and exacerbations of the bloody, fluid stools, the mild general symptoms, apart from emaciation and debility, are salient features, but an assured recognition of the affection demands a microscopic examination of the stools. Rogers suggests staining the epithelium and pus by weak methylene-blue, which leaves the amebæ unstained. Cases have been recorded by Councilman and Lafleur in which the diagnosis rested upon amebæ being found in the sputa; this was explained by the existence of a hepatopulmonary abscess, which had discharged through a bronchus; the intestinal symptoms were negative. Similar cases have been reported by Boston and others. Martinez contends that the differential diagnosis is a simple matter when 1 c.c. of fresh stool can be introduced into the rectum of a newborn kitten. In two or three days the kitten develops dysentery, generally fatal, sometimes with liver abscesses. Donaldson, Clark, and

¹ *Brit. Med. Jour.*, March 25, 1916.

McLean¹ recommend that at least five examinations of the stools be made in persons suspected of having recently had amebic dysentery.

Prognosis.—The mortality rate in certain epidemics has been frightful, particularly among soldiers in the field (amounting to 70 per cent.). In sporadic cases the danger to life is less, the mortality rate in temperate climates being not over 5 or 6 per cent. The complications which render the prognosis unfavorable are: peritonitis, hepatic and pulmonary abscess, pyemia, bronchopneumonia, malaria; death may be due to hemorrhage or peritonitis, but in a preponderating proportion of the cases to asthenia. A dangerous degree of debility is indicated by great nervous depression; a cool, clammy skin; a sunken, pinched facies; a dry tongue; a feeble, rapid pulse; and by low muttering delirium.

Course and Duration.—The average duration ranges from eight to ten weeks in uncomplicated cases; the disease can, however, be cut short by appropriate treatment. It manifests an innate tendency to pursue a chronic course, interrupted by frequent exacerbations or true relapses, and convalescence occupies a long period of time in consequence of the profound anemia and debility that supervene.

Treatment.—The diet should consist of easily digestible and nutritious solids, as raw oysters, eggs, rice, fowl, fish, and the like, in small quantities. Milk should also be freely allowed. It may be necessary to restrict the diet to fluids if diarrhea be well marked. During convalescence a return to a mixed dietary is to be adopted in a gradual manner.

A judicious hygienic regimen calculated to maintain assimilation is especially valuable. Rest in bed, combined with gentle, systematic massage, may be necessary in severe cases; in light cases graduated exercise in the open air and rest are serviceable. The medical treatment is by ipecacuanha in the form of salol-coated pills, or its alkaloid. Not less than 30 grains (2.0 gm.) of ipecac at a single dose are to be given on the first day. "Subsequently the amount is to be diminished by 5 grains (0.3 gm.) *per diem*, so that by the sixth day only 5 grains (0.3 gm.) of the drug are administered. During the next week or ten days a nightly dose of 5 grains (0.3 gm.) must be allowed."² This agent, however, does not affect the encapsulated entameba, hence does not prevent relapses. Simon³ contends that the alkaloids of ipecac, emetin, and cephaëlin, are insufficient, in safe dosage, to destroy the encysted forms of the parasite, whereas the entire ipecac root not only can be so given as to destroy the living forms but also the encysted, thereby preventing recurrences of the infection. Rogers recommends the subcutaneous injection of $\frac{1}{2}$ -grain doses of emetin hydrochlorid. Carter combines with the whole drug by mouth emetin hypodermically daily for from one to two weeks. Simon⁴ contends that the entire ipecac root when employed under proper conditions destroys both the vegetative endameba and the encysted forms, thus preventing recurrences and relapses. Ross states that the use of emetin should be remitted, at least for a time, after about ten days, especially if it has ceased to do good. Law and Dobell claim that emetin bismuth iodid is far more efficacious than the hydrochlorid. Lambert advises in all cases of amebic dysentery a course of emetin and bismuth iodid. Beck advises the treatment of dysentery with ipecac through the Einhorn duodenal tube. Colonic injections of warm solutions of quinin hydrochlorid (strength 1 : 1000 to 1 : 5000) have proved effective in the hands of most clinicians. Leroy, of Memphis, has used formalin similarly (1 : 1000),

¹ *Practitioner*, London, July, 1918, p. 1.

² Anders and Rodman, *Jour. Amer. Med. Assoc.*, February 12, 1910.

³ *Jour. Amer. Med. Assoc.*, 1918, lxxi, 2042.

⁴ *Ibid.*, December 21, 1918, p. 204.

with almost specific effects. Musgrave¹ prefers thymol, which he gives by enema. Haughwout and Lantin² have found that "benzyl benzoate exerts a definite and favorable influence on the course of endamebic dysentery." A small class of cases do not yield to the ipecacuanha treatment; they demand "appendicostomy and systematic, thorough irrigations through the appendix." Recurrences will yield to the same means, and they can sometimes be prevented by promoting the repair of the blood and tissues during the intervals, a contention sustained by Sollman.³

FLAGELLATA MASTIGOPHORA

During the motile period of their existence these organisms possess one or more flagella attached to either or both ends in the various forms, and some of them also possess an undulating membrane, the trypanosomes being the best exemplars of this latter group. The body of these parasites is very small, many with rounded anterior portion, pointed posteriorly; others are spindle shaped. They are nucleated, often have vacuoles, and some contain chlorophyl.

Trichomonas vaginalis lives in an acid medium. It is not found in normal vaginal secretion, but in vaginal catarrh with acid secretion; it may occur at any age from childhood to advanced life. It is a specific parasite of the female generative tract, though, rarely, it has been found in the urine of men, probably introduced through coitus. It is not known how they gain entrance to a woman. Alkaline solutions destroy them, as does cold.

Trichomonas intestinalis and *pulmonalis* are met with in stools, urine, sputum, secretions from mouth; but these forms are not pathogenic.

Lamblia (*Cercomonas*) *intestinalis*—a monad commonly met with in intestinal discharges; not believed to be pathogenic. Cercomonads have been found (*Cercomonas hominis*) in discharges of cholera patients and (*Bodo urinaris*) in urine. Smithies⁴ in routine examination of the stools of 1000 patients from the northwestern states found intestinal parasites in 93; 36 of these were infestation by the *Cercomonas intestinalis hominis*, and 21 were *Trichomonas intestinalis hominis*. As the great majority of these patients suffered from diarrhea, loss of weight, dyspepsia, subacidity, anemia, and other symptoms it seems fair to assume that while in some cases the parasites may not be pathogenic, in others they are capable of producing well-marked symptoms.

Balantidium coli (*Paramœcium coli*) is found in discharges from obstinate cases of colitis; also in mucosa, and even submucosa, of rectum and colon. Stokvis has found it in the sputum of a case of pulmonary abscess. The pig is believed to be the source from which man is infected. Mason believes balantidiosis to be less rare than is usually supposed and that it is frequently overlooked in the routine examination of stools owing to the chronicity of the ulcerative process in infected cases. Tagliaferro states that 153 cases of balantidiosis are on record, with a death-rate of 23 per cent. More recently de Bellard⁵ reports another case which was cured by flushing the colon twice daily with 1 liter of a 1:1000 solution of quinin sulphate and the use of 3 drops of an iodid (Lugol's solution) taken internally three times a day.

¹ *New Orleans Med. and Surg. Jour.*, May, 1911.

² *Arch. Int. Med.*, 1919, xxiv, 383.

³ *Jour. Amer. Med. Assoc.*, 1919, lxxiii, 1125.

⁴ *Amer. Jour. Med. Sci.*, 1918, clvi, 173.

⁵ *de Caracas*, 1919, xxvi, 27.

TRYPANOSOMIASIS

SLEEPING SICKNESS

The trypanosoma is a flagellated hematozoön common to the lower animals, and has been found in man. *Trypanosoma hominis* is a minute, colorless, translucent, active protozoön, tapering toward its extremities, the anterior of which displays a long flagellum. The body of the organism is finely granular. It is found free in the plasma. Trypanosomes have been known for over sixty years, but their pathologic import was first pointed out by Evans in surra, a disease of horses and cattle in India, *Trypanosoma evansii*. In May, 1901, Forde found the organism in the blood of an Englishman suffering from an irregular chronic fever, at first thought to be malaria. Six months later Dutton found and recognized the nature of the organism in the blood of this same patient, though about ten years before Nepven, a French observer, had seen the same or a similar parasite in man, this being the first time that man was found to be subject to infection from trypanosomes. Dutton suggested the name *Trypanosoma gambiense* for the parasite, and trypanosomiasis for the disease. *Trypanosoma rhodesiensi* is a species of the genus trypanosoma found chiefly in Rhodesia. Wild game are the chief conveyors of *Trypanosoma rhodesiensi*, 16 per cent. of wild game in Rhodesia according to Bruce and to Eckman. Trypanosomiasis is engrossing a large proportion of the professional attention at the present day of Europe, Asia, Africa, Australia, and even America. Castellani found the trypanosoma in the spinal fluid, obtained by lumbar puncture, in 20 out of 34 cases of sleeping sickness, but Bruce first showed the pathologic relationship between sleeping sickness and trypanosoma, and that the agent of transmission is the tsetse fly of the genus *Glossina palpalis*, although all of the tsetse flies may act as vectors. This fly is not found in America.

Trypanosomes have been found associated with many diseases of man and animals, and Manson believes that three of these—*i. e.*, the *Trypanosoma brucei*, a tsetse-fly disease, causing nagana in horses and cattle; *Trypanosoma evansii*, and the trypanosome of mal de caderas—are closely allied species, if not identical. Recently Broeden discovered in the Congo country a trypanosome which is pathogenic for cattle, rats, guinea-pigs, and monkeys, and the infection is essentially like that produced by other trypanosomes.

Symptoms and Diagnosis.—Early the *skin* may appear nearly normal, but Ford and Manson have described blotches of erythema, isolated areas of edema, especially of the eyelids, and later general edema and cachexia. The *tongue* is red and raw. There are wasting, general malaise, and decided weakness of the lower limbs. The *pulse* may reach 120 beats per minute. Tachycardia and muscular weakness are the rule. Fever may develop at intervals or may occur daily for an indefinite time, ranging from 100° to 104° F. (37.7°–40° C.). Lethargy is the dominating feature of these cases. In addition to the cutaneous symptoms, which may resemble leprosy, there are restlessness, difficulty in speech, delirium, Cheyne-Stokes respiration, and coma. *Splenic enlargement* and tenderness were present in Ford's cases. The lymphatic glands are enlarged and contain trypanosomes. An irregular remitting fever is a leading symptom of the first stage. There is general *anemia* of the simple chlorotic type. Ophthalmoscopic examination may show mottling of the fundus. The Liverpool School of Tropical Medicine maintains that gland palpation is the most efficient means of diagnosis of human trypanosomiasis, other causes for the glandular enlargement being absent (J. L. Todd).

LEISHMANIASIS

These are specific infectious diseases caused by the protozoa of the genus *leishmania*. The systemic condition has been called at various times kala-azar, febrile tropical splenomegaly, and Dumdum fever. The local disease of the skin is called oriental sore.

KALA-AZAR (SYSTEMIC LEISHMANIASIS)

Definition.—It is a chronic disease, characterized by anemia, irregular fever, emaciation, pigmentation of the skin, enlarged spleen, and by a protozoön organism, *Leishmania donovani*, which is found in the spleen, liver, bone-marrow, lymph-glands, adrenals, testicles, intestinal and cutaneous ulcers, inflammatory exudates, and only very rarely in the blood.

The disease is met with in India, Assam, China, Egypt, and Africa. Epidemics move forward very slowly—about 14 miles a year—the disease clinging to a place for almost five years and then disappearing.

Etiology.—In 1885 Cunningham, and in 1901 Firth, called attention to certain minute bodies to be found in the protoplasm of the cell exudate of the base of the oriental sore or Delhi boil. In November, 1900, Leishman found these bodies in smears from the spleen of a case of Dumdum fever in a soldier invalided home from India. In the winter of 1902–03 Major Leishman noted these same organisms in smears of blood and internal organs from a trypanosome-infected rat. In May, 1903, he published these observations, and suggested that the organisms were trypanosomes. Soon after Donovan found them in fluid obtained by splenic puncture from an Indian, hence the name, Leishman-Donovan body. Low, Manson, Rogers, Bentley, and others have since found them. They are minute, oat-shaped, oval, or round bodies, with faintly staining protoplasm, but deeply staining chromatin masses, usually placed at opposite poles of the cell. Rogers succeeded in cultivating these bodies in citrate of soda solution, typical flagellated organisms resulting—the proof of their nature. Unlike the usual type of trypanosomes, the flagellum is attached to the end of the body at which the micronucleus is situated, and it does not possess an undulating membrane. It probably escapes from the body of the infected individual in the discharges from cutaneous or intestinal ulceration, and in all likelihood the intermediate host is some biting insect.

Predisposing Causes.—One-third of the cases occur under twenty years of age, and the Hindus were more frequently affected by the disease than the Mohammedans, the proportion being about 4 to 1 (Brahmachari).

Symptoms.—There is fever, irregular in type, generally remittent, often comparatively long intermittent periods, the whole extending over some months. The fever may occur in ague-like attacks. A dirty, sallow, anemic appearance of the cutaneous surface is noted, and occasionally areas of pigmentation. Enlargement of the spleen and liver occur early, the former being an invariable accompaniment, while the latter is less constant. Dyspnea, emaciation, progressive and, finally, extreme weakness, and more or less edema are present. Leukopenia, in which the proportion of white or red corpuscles may be less than 1 to 1000 with relative low polymorphonuclear counts, is almost diagnostic of the disease. Cutaneous and intestinal ulceration develop various hemorrhages or purpura, and these, in an extremely emaciated individual with a large protuberant belly, make a picture fairly characteristic. Death often results from some intercurrent affection. Among the commoner complications are pneumonia, pulmonary tuberculosis, abscesses, and splenalgia due to infarcts in the spleen.

Prognosis.—Manson regards the disease as absolutely hopeless; he has never seen a case recover. Rogers places the mortality at 96 per cent. Donovan gives an equally gloomy prognosis.

Treatment.—Tonic and hygienic. Quinin is of no special value, but may be employed with iron and arsenic. Bahadur¹ has treated kala-azar with injections of metallic antimony in normal saline solution. Masters² advocates intramuscular injections of oxid of antimony dissolved in equal parts of glycerin and water, slightly heated. Tartar emetic is also given intravenously and apparently is a specific, though many injections are necessary. When possible, segregate infected cases, since no other known method of prevention exists, and, as we have seen, once developed, it proceeds to a fatal issue.

Dermal Leishmaniasis.—The *oriental sore*—Delhi or Bagdad boil, a local infection, without constitutional symptoms—is due to the *Leishmania tropica*, indistinguishable by its morphologic characteristics from the *Leishmania donovani*, but it is not fatal, and one attack, as a rule, gives immunity. Manson says it has been noted that oriental sore is peculiar to camel-using countries, and if this really be due to the same leishmania as kala-azar, that a reduction in virulence of the organism has been attained by passage through the camel, as is the case with small-pox in its passage through the cow. The inference is, therefore, that the virus of oriental sore should be employed in an attempt to protect against kala-azar. The disease prevails at all ages, in both sexes, and shows a predilection for the natives and old residents.

Brazilian dermal leishmaniasis, according to Ashford, is “a clinical variety of oriental sore, although the organism is apparently identical and the skin lesion the same.” The disease is extremely prevalent in Brazil, Peru, and Paraguay. The ulceration involves chiefly the soft tissues of the nasopharynx and is horribly mutilating.

Treatment of dermal leishmaniasis is the same as the systemic form.

PSOROSPERMIASIS

Psorosperms belong to the lowest form of protozoa. They are also known as *sporozoa*, and, because of their parasitic relation to cells, as *cytozoa*. A common form occurs in the muscles of the pig (*Sarcocystis miescheri*). The *Amæba coli* of amebic dysentery belongs to the protozoa. Various coccidia may occur in man (*e. g.*, *Sarcocystis hominis*) to produce the disease indicated by this heading.

(a) *Internal Psorospermiasis.*—In man hepatic disease similar to that found in the rabbit is produced by the *Coccidium oviforme*. The tumors formed by the coccidia may be palpable, and the liver may be quite tender. Some chilliness and fever, malaise, and stupor passing into coma have been observed. Death was caused on the fourteenth day in a case admitted to St. Thomas' Hospital (Osler). The necropsy showed whitish neoplasms in the peritoneum, omentum, kidneys, pericardium, liver, and spleen.

In the intestinal variety of *internal psorospermiasis* nausea and vomiting, diarrhea, and the typhoid state may be manifested. Involvement of the kidneys has caused hematuria and frequency of urination.

(b) *External Psorospermiasis.*—*Cutaneous psorospermiasis*, one form of which was formerly called *keratosis follicularis*, is characterized by lesions at first of a hard, crusty, papular type, later becoming confluent, and situated

¹ *Indian Med. Gaz.*, Calcutta, December, 1915.

² *Jour. Trop. Med.*, July 15, 1918, p. 146.

on the face, lumbo-abdominal, and inguinal regions. These papillomatous growths contain either parasitic sporozoa or, as suggested by Montgomery and others, parasites that belong to the blastomyces.

In carcinoma, epithelioma, and Paget's disease of the nipple coccidia are readily found in and between the pathologic epithelial cells, but whether they have an etiologic bearing upon these malignant affections is still a matter of uncertainty.

Prophylaxis consists in cleanliness and care in preparing such food vegetables as spinach, lettuce, cabbage, and other greens that may possibly be contaminated by the excreta of the lower animals liable to psoroform infection.

The treatment of psorospermiasis is largely symptomatic, though rectal injections of a solution of quinin (1 : 5000 to 1 : 1000) may be tried. Potassium iodid in ascending doses has been recommended.

MALARIAL FEVER

(*Chills and Fever; Fever and Ague; Swamp Fever*)

Definition.—An infectious, non-contagious disease caused by the hematozoon of Laveran. It is characterized by splenic enlargement, brief febrile attacks which recur periodically, melanemia, and a tendency in protracted cases to irregular fever and extreme anemia. The following subvarieties will be discussed: (I) *Intermittent fever*; (II) *pernicious intermittent*; (III) *remittent fever*; (IV) *malarial cachexia*; (V) *masked intermittent*, and (VI) *malarial hematuria*.

Historic Note.—There are few diseases with which the profession has been acquainted longer than with malaria, and chief among the earliest known hotbeds of this disease were the city of Rome, the Pontine marshes about the latter, and the swamps along the lower Danube. It is pretty generally believed that the prevalence of the disease has long been, and still is, diminishing. This view is fully corroborated by my own observation, upon the cases from four leading hospitals of Philadelphia. The drying of marshy districts of a malarious character, thereby rendering them unsuited to the development of the mosquito, is the cause of this decreased prevalence.

New England, once a region in which the disease was very prevalent, now affords few cases. Again, in the southern portion of the United States, where the severer forms of malaria prevailed extensively in the past, a marked tendency to progressive reduction in the number of cases has also been observed. In foreign lands (England and Continental Europe) the constantly decreasing prevalence and virulence of this disease have been noted by numerous careful observers. The relation between malaria and the mosquito is suggested in the writings of such ancient authors as Columella and Varro. The peasants say "in such a place there is much fever because it is full of mosquitos." Shepherds returning from the European mountains to their cabins smoked them to drive out the mosquitos. The sheep occupied the cabins at periods, when the famished mosquitos inflicted their bites upon these animals, after which they showed little tendency to bite man (an ancient prophylaxis). Mbù is the term used in Eastern Africa for both malaria and the mosquito.

In 1848 Noth, of America, maintained that both yellow fever and malaria were transported by the mosquito, and King in 1883 showed that malaria was transmitted in this manner. In 1891 Laveran recognized the mosquito as an intermediary host of this parasite. Similar views were held by Pfeiffer and Koch in 1892 and Bignami in 1894.

sexual fertilization takes place in the mosquito's stomach or middle intestine within the first twelve hours.

(4) Manson correctly supposed that the mosquito sucked blood from malarial subjects. Surgeon-Major Ross, of Liverpool, began his investigations in India in 1895 by endeavoring to determine what became of the parasite after fertilization in the mosquito's stomach. During August and September, 1897, two members of the species *Anopheles maculipennis*, bred from the larvæ, were fed on the blood of patients containing crescents, and he found that peculiar spheroidal cells developed on the walls of their stomachs, which convinced him that "these cells constituted the long-sought mosquito stage of the parasite" (zygote).

In 1898 Ross studied the "zygotes of protozoma" of birds. He found that they attached themselves to the outer coats of the mosquito's stomach. The zygote grows rapidly, without movement or change in form, protruding into the insect's body cavity. Later its capsule becomes easily perceptible and the cell substance is seen to divide into from 10 to 12 "meres." In from one to three weeks, depending on the external temperature, the zygote matures, when each mere contains a number of delicate, "thread-like" blasts.

The next step in the development of the parasite is the rupture of its capsule, setting free these "thread-like" blasts within the insect's body; they are then carried by the blood's currents to all its tissues, more particularly into the insect's salivary gland. The common duct of the salivary gland of the mosquito (genus *Anopheles*) passes along the middle stylet of the proboscis, opening at its extremity, and a portion of the secretion of this gland is poured into the wound caused by the insect's bite. In the human body the blasts return to the amebulæ, with which the life-history of this parasite began.

(5) In 1898 Grassi found three chief species of the mosquito in malarious localities, the *Anopheles claviger* being constantly present. King's experiments show several species of anopheles to be efficient hosts: *Anopheles punctipennis*, *Anopheles crucians*, *Anopheles quadrimaculatus*. The latter species has been considered to be the principal one concerned in the transmission of malaria in the United States. Manson gives 32 members of the family Anophelinæ, which have been shown, with more or less precision, to be hosts of the malarial parasites. Banks has shown conclusively that *Myzomyia hallowi* should be added to the list. The chief carrier in the Philippines is the *Anopheles febrifer*—a stream breeder, widely distributed.

In November, 1898, Bastianelli, Bignami, and Grassi conducted a series of experiments by feeding mosquitos the blood from persons suffering from estivo-autumnal fever, confirming the findings described by Ross in August, 1897. These investigations showed the *mode of infection*; that healthy mosquitos became infected by sucking blood from malarial patients, and that in from eight to twenty-one days such insects may infect healthy men by their bite. One mosquito may infect many persons, and may possess this power for an indefinite period "since not all of the germinal threads escape from the venomosalivary gland" (A. Woldert). Neither the common house mosquito (genus *Culex*) nor the *Anopheles nigripines* takes part as an intermediary host for this parasite. The fact that mosquitos (*Anopheles claviger*) are known to occupy non-malarious districts proves the innocence of the uninfected insects. A single case of malaria transported to such territory often results in an epidemic.

(6) Bass has succeeded in growing the malarial parasites in the test-tube. He employs as his media 0.1 c.c. of a 50 per cent. solution of glucose to which is added 10 c.c. of defibrinated blood, the whole being incubated at 40° C. (104° F.). It has been shown as a result of Bass's method of growing the para-

site that *Plasmodium falciparum* in its older forms has a strong tendency to clump, thus proving that the parasites clump in the capillaries and consequently make malignant malaria an extremely grave disorder.

The *malarial parasite* of Laveran belongs to a subclass of the protozoa known as hematozoa (*hæmamebæ*). Of the latter, three varieties, corresponding with the three leading clinical forms of the affection, have been distinguished in man, and the evolution of two of these parasites at least takes place within the red blood-corpuscles. Manson describes five species which he classifies as follows:

Benign { Tertian
Quartan } do not form crescents.

Malignant { Quotidian—pigmented
Quotidian—unpigmented
Tertian } form crescents.

They enter the red cells in the form of small, non-pigmented plasmodia, exhibiting ameboid motion, and then feed upon their host, transforming, at the same time, the hemoglobin of the latter into dark pigment granules as they develop. The special varieties of the malarial parasite as observed in microscopic studies of the blood of human beings will be described separately.

(1) *The Hæmameba Causing Tertian Intermittent Fever*.—This begins its asexual cycle of evolution in the red blood-corpuscles as a small hyaline ameba. Its development is attended with the appearance in its interior of fine, brown, motile granules in the form of pigment, and when matured it about equals the size of a normal red corpuscle. It now assumes a spheric form, the pigment collecting centrally, and sporulation into fifteen to twenty or more segments follows. The tertian parasites are exceedingly numerous in the blood, and pass through the various stages of their life cycle almost simultaneously, the sporulation of an entire generation occurring within the space of a few hours (Golgi). The occurrence of the malarial paroxysms follows the process of sporulation, which is attended, most probably, with the development of a *toxin*, and the symptoms of the disease may be attributable chiefly to the effects of the latter. The red corpuscle that includes the parasite becomes enlarged and decolorized as the latter develops. The parasite of tertian intermittent runs its cycle in about forty-eight hours. Hence infection by a single generation would result in sporulation every second day, followed by the malarial paroxysm. Quite commonly, infection by two groups of parasites occurs on successive days, and, since each has a definite period of evolution, a daily malarial paroxysm is the result (quotidian intermittent). Multiple infection with this parasite may occur, but with great rarity.

(2) *The Hæmameba Causing Quartan Fever*.—This cannot be distinguished from the tertian parasite at the beginning of its asexual career, but later differences are clearly perceptible. Its ameboid movements are more deliberate, and its pigment granules are coarser, darker, and also less motile than those of the tertian organisms. Unlike the latter, it does not attain the size of the red corpuscles, and during sporulation the segments (five to ten in number) encircle in an orderly way the central pigment mass or clump, "rosettes" of great beauty thus being formed. The red blood-corpuscle that harbors the quartan parasite contracts upon its destroyer, appears shriveled, and its color changes at the same time from the normal to a deep greenish or bronzed tint. It sporulates about seventy-two hours after it enters the red corpuscle; hence, if only one group of parasites be present, febrile attacks occur every fourth day—quartan intermittent. On the other hand, double quartan

DESCRIPTION OF PLATES I. AND II.¹

The drawings were made with the assistance of the camera lucida from specimens of fresh blood. A Winckel microscope, objective $\frac{1}{4}$ (oil immersion), ocular 4, was used. Figures 4, 13, 23, 24, and 42 of Plate I. were drawn from fresh blood, without the camera lucida.

PLATE I.

THE PARASITE OF TERTIAN FEVER.

- 1.—Normal red corpuscle.
- 2, 3, 4.—Young hyaline forms. In 4, a corpuscle contains three distinct parasites.
- 5, 21.—Beginning of pigmentation. The parasite was observed to form a true ring by the confluence of two pseudopodia. During observation the body burst from the corpuscle, which became decolorized and disappeared from view. The parasite became, almost immediately, deformed and motionless, as shown in Fig. 21.
- 6, 7, 8.—Partly developed pigmented forms.
- 9.—Full-grown body.
- 10-14.—Segmenting bodies.
- 15.—Form simulating a segmenting body. The significance of these forms, several of which have been observed, was not clear to Drs. Thayer and Hewetson, who had never met with similar bodies in stained specimens so as to be able to study the structure of the individual segments.
- 16, 17.—Precocious segmentation.
- 18, 19, 20.—Large swollen and fragmenting extracellular bodies.
- 22.—Flagellate body.
- 23, 24.—Vacuolization.

THE PARASITE OF QUARTAN FEVER.

- 25.—Normal red corpuscle.
- 26.—Young hyaline form.
- 27-31.—Gradual development of the intracorpuseular bodies.
- 32.—Full-grown body. The substance of the red corpuscle is no more visible in the fresh specimen.
- 33-39.—Segmenting bodies.
- 40.—Large swollen extracellular form.
- 41.—Flagellate body.
- 42.—Vacuolization.

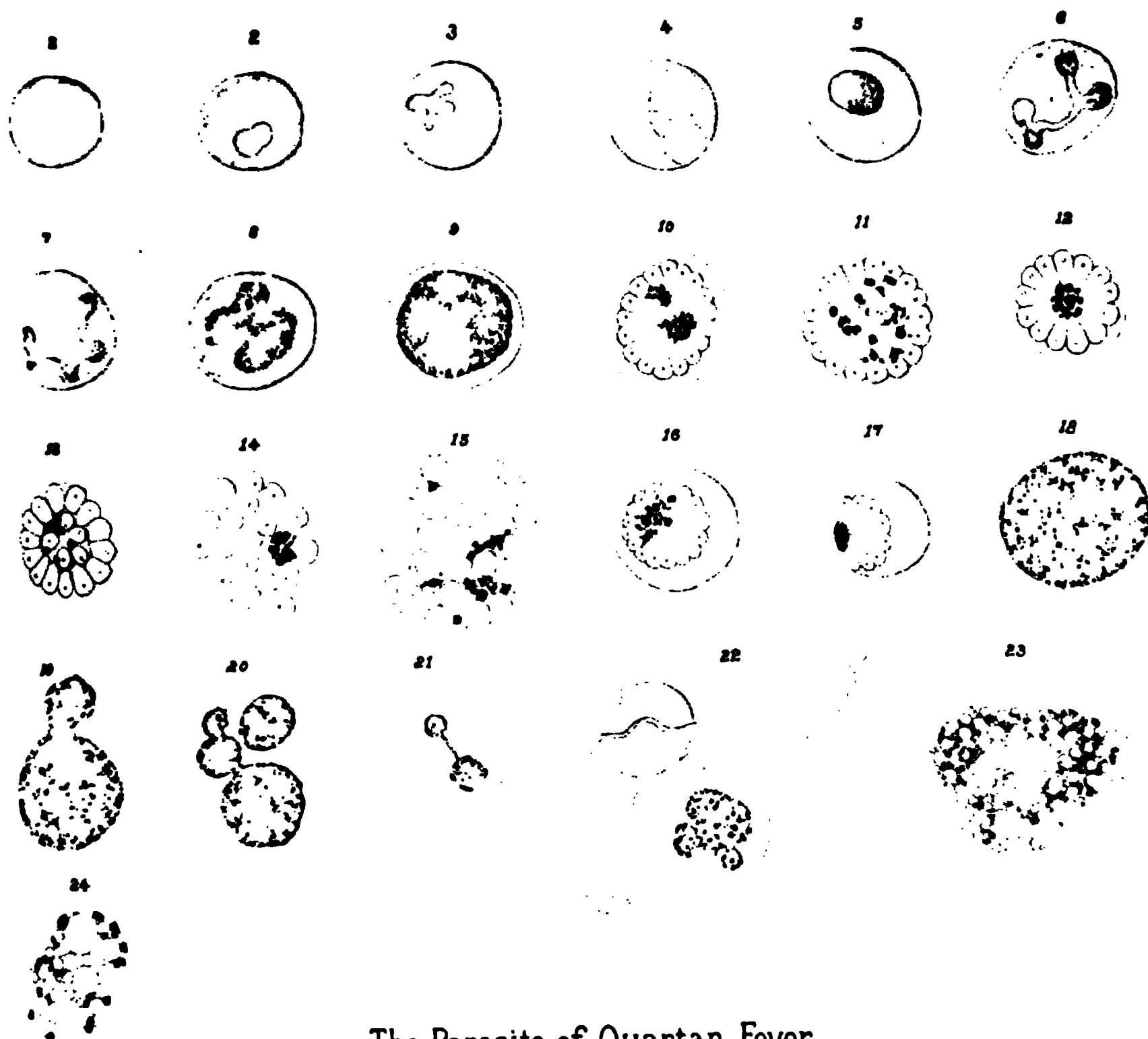
PLATE II.

THE PARASITE OF ÆSTIVO-AUTUMNAL FEVER.

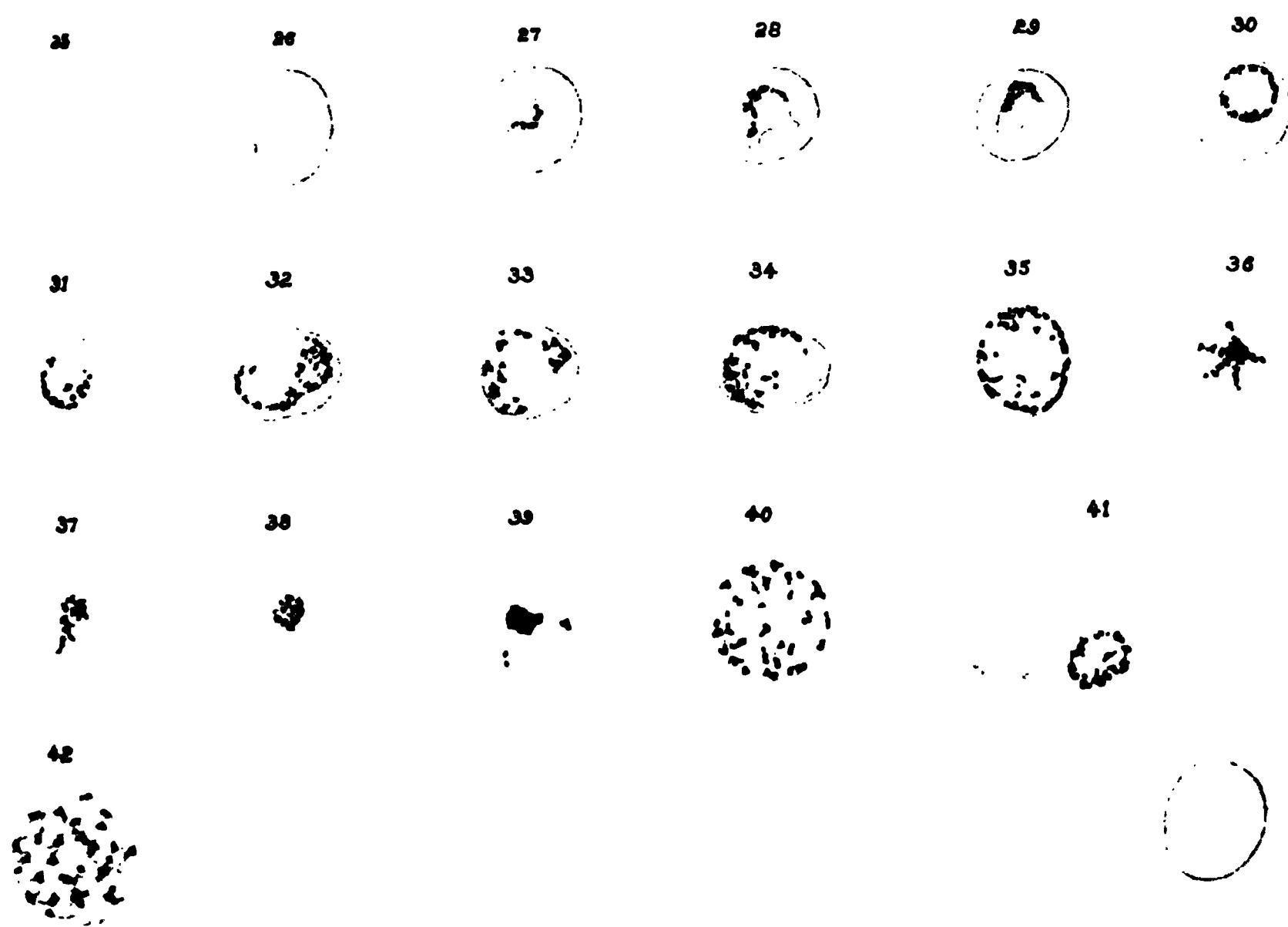
- 1, 2.—Small refractive ring-like bodies.
- 3-6.—Larger disk-like and ameboid forms.
- 7.—Ring-like body with a few pigment-granules in a brassy, shrunken corpuscle.
- 8, 9, 10, 12.—Similar pigmented bodies.
- 11.—Ameboid body with pigment.
- 13.—Body with a central clump of pigment in a corpuscle, showing a retraction of the hemoglobin-containing substance about the parasite.
- 14-20.—Larger bodies with central pigment clumps or blocks.
- 21-24.—Segmenting bodies from the spleen. Figs. 21-23 represent one body where the entire process of segmentation was observed. The segments, eighteen in number, were accurately counted before separation, as in Fig. 23. The sudden separation of the segments, occurring as though some retaining membrane were ruptured, was observed.
- 25-33.—Crescents and ovoid bodies. Figs. 30 and 31 represent one body, which was seen to extrude slowly, and later to withdraw, two rounded protrusions.
- 34, 35.—Round bodies.
- 36.—"Gemination," fragmentation.
- 37.—Vacuolization of a crescent.
- 38-40.—Flagellation. The figures represent one organism. The blood was taken from the ear at 4.15 p. m.; at 4.17 the body was as represented in Fig. 38. At 4.27 the flagella appeared; at 4.33 two of the flagella had already broken away from the mother body.
- 41-45.—Phagocytosis. Traced with the camera lucida.

¹These illustrations are reproduced by permission from the article by Drs. Thayer and Hewetson in *The Johns Hopkins Hospital Reports*, vol. v., 1895.

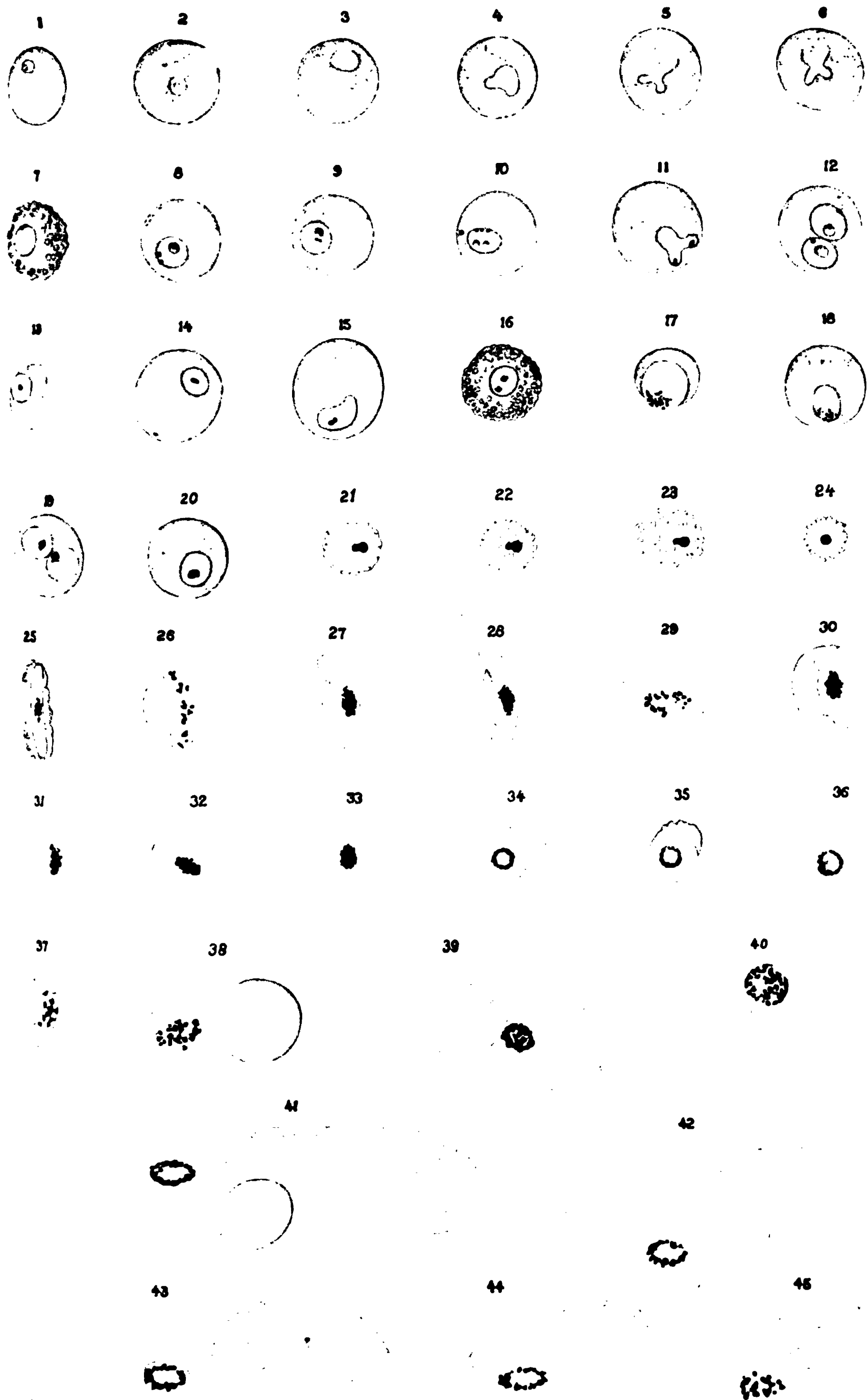
The Parasite of Tertian Fever.



The Parasite of Quartan Fever.



The Parasite of Aestivo Autumnal Fever.



infection results in paroxysms on two successive days, followed by an intermission lasting one day, while triple infection, or the presence of three groups, causes daily paroxysms—the quotidian intermittent. Infection by more than three groups of the quartan parasite may occur, but is very rare.

(3) *The Hæmameba Causing Estivo-autumnal Fevers*.—The endogenous cycle of this variety is evolved chiefly in certain of the internal viscera, and the microscopic examination of the blood in the various stages of the disease does not always give a positive result, as in benign tertian and quartan. The organism invades the red blood-corpuscle, but to what extent is questionable. It is a quite small hyaline body, its size at maturity scarcely equaling one-half the dimensions of the red corpuscle, and it accumulates a few fine pigment granules. The parasite may be found in the later stages in the blood from certain internal viscera, as the spleen. After the condition has lasted a time characteristic oval and crescentic bodies, which are more or less refractive, may be observed in the fresh blood. These so-called “sickle-form bodies” show central rods and clumps of coarse pigment, and are connected with the malignant type of malarial fevers. Ring-form bodies, and at times, the signet-ring forms are observed. The red corpuscle, at whose expense the parasite develops, assumes a brassy-green hue, becoming shriveled and crenated. Mary Rowley-Lawson¹ believes that the malarial parasite is always extracellular, attached to the outside of the erythrocytes by means of pseudopodi. She believes, further, that the parasites migrate from cell to cell and thus each parasite may kill several cells. In this way she explains the anemia of malaria, which is out of all proportion to the number of parasites in the blood.

It would appear from the studies of Manson, Marchiafava, Bignami, and Surgeon Craig that two varieties of parasite are concerned—quotidian and tertian forms of autumnal fevers (*vide* table, p. 334).

The parasites of tertian estivo-autumnal fever are larger than the quotidian parasite, and during the hyaline stage the signet-ring form, sluggish ameboid movement, clear-cut refractive outline, and the occurrence of one organism in a blood-cell which is not wrinkled are observed; during the pigmented stage, the ameboid movement and fine granular motile pigment. Segmentation takes place outside the corpuscle. Crescents are large, slender, and deeply pigmented (see Plate II).

The quotidian parasite is smaller, at times actively ameboid, and more than one parasite may occupy a single red cell, which is usually wrinkled. Their pigment is motionless, and usually in the form of short rods. Unpigmented parasites also occur (Manson). Crescents are small, plump, and often present a double outline. Segmentation occurs within the red corpuscle.

Development of Flagella.—Some of the crescents become ovoid with scattered pigment; this in turn becomes more or less spheric, the pigment forming a central ring; “this finally approaches the periphery, the whole parasite becomes violently agitated, throwing out flagella, which have a wave-like motion, many of which break away” (Wright).

PREDISPOSING CAUSES.—(1) **Soil**.—Fresh-water marshes favor the development of mosquitos, and are most fruitful in influencing their growth when located near the coast and tainted with salt water. Again, marshy districts affording luxuriant vegetation are notorious as malarial foci. Keeping in remembrance the foregoing facts, we can readily see why malaria is unusually prevalent in certain countries (chiefly tropical), and why it is chiefly confined to the low-lying estuaries and the deltas of rivers. The same facts explain satisfactorily why certain districts which were very liable to the affection should have become, as the result of denudation of the virgin soil and its subsequent drainage

¹ *Jour. Exper. Med.*, 1914, xix, 450.

and cultivation, entirely free from the complaint. Epidemics following the upturning or the removal of the surface of the virgin soil are probably due to importation of the disease (or infected mosquitos), and are common on the frontier of the South and West.

(2) **Climate**.—Malaria is more prevalent in tropical and subtropical than in temperate climates, and more common in the latter than in the polar zones. Hence it occurs more frequently in the southern than in the northern States of our own country.

(3) **Rapidly growing trees** dry the soil by absorbing enormous quantities of water. In the Roman Campagna extensive experiments have been made with the eucalyptus tree, districts protected in this manner becoming almost entirely free from malaria in a few years, the environment being unsuited to the mosquito.

(4) **Seasons**.—In temperate latitudes most cases are developed in the autumn, the maximal period corresponding with the month of September. This dictum is based upon 4841 cases of malaria gathered by the author from the records of the leading Philadelphia hospitals. Cases that develop before the *Anopheles claviger* makes its appearance (in June) are possibly relapses. A continued temperature below 65° F. (18.3° C.) does not permit of the development of sexual forms in anopheles and kills those already matured. In the tropics the case seems to be different, the two maximum periods—spring and autumn—obtain. Statistics from the hospitals of Rome, collected from 1864 to 1898, show the maximum number of cases to occur in August, September, October, November, and July, respectively, and in June the minimum number.

(5) Persons occupying the upper stories of a house or living on elevations are affected with relative infrequency, for the reason that mosquitos are always found near the earth's surface, where the air-currents are feeble. This fact also explains nocturnal infection.

(6) **Race** exerts little influence, but in the United States negroes are slightly less susceptible than the whites.

(7) **Sex** is without effect when men and women are equally exposed. Cases are, however, vastly more frequent among males because of their increased liability to mosquito bites while following certain occupations (agriculture, marsh-draining). On the other hand, Clark¹ claims that the pregnant state encourages attacks of malaria. The 5044 cases collected by me gave the numerical proportion of 6 to 1 in favor of males.

(8) **Age**.—Children are more susceptible than adults. Tejera reports finding the *Plasmodium vivax* in one child and the *falciparum* in another in the blood taken a few minutes after birth from the finger.

(9) The disease may flare up after either an accident or surgical operation.

IMMUNITY.—There are individuals immune from malaria and experimental malaria. An individual may present this property after a mild fever has been cured by quinin. Maurel has shown that when living in the malarious district whites may in time show marked immunity. By the use of methylene-blue and euchinin immunity may be established against the inoculation of from 1 to 2 grams of estivo-autumnal blood.

INCUBATION.—According to Bignami and Bastianelli, the period of incubation for experimental malaria is: Quartan, fifteen days; spring tertian, twelve days; estivo-autumnal tertian, five days. The administration of potassium bromid, potassium iodid, arsenic, carbolic acid, antipyrin, and phenocoll may result in a longer period. Angelo Celli has seen spring tertian show incubation of twenty-two days, and the estivo-autumnal tertian, seventeen days.

¹ *Jour. Exper. Med.*, October, 1915.

Epidemiology.—Estivo-autumnal fevers are rare in their recurrence, while mild tertian and quartan prevail with each new spring, and the first cases of tertian are noted to occur in the same houses in which the last recurrences of these fevers appeared. After the first cases there is a lapse of from seventeen to eighteen days, after which the epidemic spreads. The life and habits of the *Anopheles* have a direct bearing upon epidemics—"either the first cases of these fevers in July are recurrences of a previous infection, or the very first cases of these fevers in July are primary" (Celli). "Both hypotheses are possible. In both we have to deal with a contagion circulating, so to speak, between the temporary host (man) and the definitive host (mosquito), a contagion which, by means of the blood of the relapsing cases of the preceding year, is transmitted by the agency of mosquitos, and starts the epidemic of the following year." There are many interesting questions not yet explained.

(I) **Intermittent Fever.—Symptoms.**—The clinical history presents itself under two heads: (a) the paroxysms and (b) the manner in which the paroxysms recur.

(a) *The Paroxysms.*—There may be premonitions lasting from one to several days, and most significant, yet not distinctive, are headache, pain in the nape of the neck, yawning, a yellowish complexion, and a slight splenic enlargement. In a large proportion of the cases, however, the onset is abrupt. Typical paroxysms present three stages—*chill*, *fever*, and *sweating*. The chill is intense, causing shivering and often chattering of the teeth. Malaise is marked, the skin is cool and pale, face slightly cyanotic, and limbs painful. This stage usually occurs in the morning hours, but the time of onset is not constant; its duration, also, varies greatly, generally lasting from one to two hours. The temperature rises rapidly; the pulse is small, rapid, and of high tension.

The *hot stage* succeeds the chill, and, in contrast with the first stage, the face wears a decided flush and the skin is burning hot to the touch. The temperature continues to rise, but not so rapidly as in the first stage. Its maximum level, usually from 104° to 106° F. (40–41.1° C.), is soon reached, and may either be maintained uniformly for several hours, or the curve may show two small summits if the temperature be recorded frequently (Fig. 26). The pulse is full and bounding except in the rare instances in which acute dilatation of the heart ensues, when it is quite feeble and sometimes irregular. The headache is now of a rending, splitting character, due to cerebral congestion. The length of the second stage is from three to six hours. The temperature generally begins to decline before the close of the febrile stage.

When *sweating*, which soon becomes profuse, sets in, the symptoms of the hot stage are promptly relieved. The temperature falls by crisis, touching the normal level in a few hours; the decline, however, is less rapid than the rise at the beginning of the paroxysm. The fall may be unbroken by any fresh elevations of temperature, though more often the latter occur. Less frequently defervescence occurs by steps, the temperature falling one or more degrees, and remaining at the new level for a short period; then dropping again about an equal distance, and so on until the normal is reached. Usually, following the paroxysm, the temperature becomes subnormal (about 97° F.—36.1° C.). The length of the typical malarial paroxysm ranges from eight to twelve hours.

(b) *The Manner in which the Paroxysms Recur.*—The special characteristic of this form of intermittent is the regularity with which the paroxysms recur in cases that are not under treatment. The intermission, or time between two successive paroxysms, is most frequently twenty-four hours (quotidian inter-

by palpation. The organ can be shown to increase in size with each succeeding paroxysm. Tenderness is elicited on pressure, and commonly outlasts the course of the affection for a considerable length of time. Moderate enlargement of the liver may be present, but this is not so constant as enlargement of the spleen.

Connected with the *skin* are two symptoms of considerable diagnostic value: (1) a *yellowish-brown discoloration*, the so-called "malarial complexion," due to the deposition of pigment, and (2) *herpes*. The latter occurs usually on the prolabia or on the nose, though rarely elsewhere. DeBrun¹ describes an erythema of a pale pink or light violet color, but which may sometimes be a bright pink or lilac. It spares only the face, neck, soles, and palms. Other skin eruptions, as urticaria and purpura, have been described by authors, but they have no real clinical worth.

As stated under Pathology, *acute dilatation of the heart* may develop, attended with the usual physical signs of this condition, but it rarely lasts longer than the brief febrile paroxysm. Murmurs of functional origin may also be heard in the heart during the attack. The blood-pressure is subnormal, as a rule, in this disease. The *lungs* upon auscultation sometimes present the signs of a dry bronchitis.

The *urine* may contain a small amount of albumin, and rarely there is acute nephritis—a rather common sequel in the negro. There is a temporary increase in the amount of urea eliminated, and this may be observed from two to six or eight hours before the chill (Jaccoud).

Gastro-intestinal symptoms may be present, as diarrhea, which is sometimes considerable, *catarrhal jaundice*, and paroxysmal vomiting, but these are limited to the graver forms of intermittent.

There is a rapid diminution in the number of both red and white corpuscles proportionate "to the severity and the number of the attacks" (W. W. Johnston). The leukopenia is associated with an increase of large mononuclear leukocytes. Thomson emphasizes leukoctic variation at different times of day, correlating these with the stage of development of the parasites; he also found that the more numerous the parasites, the greater the leukopenia, whereas a small number on sporulating cause a leukocytosis. Macfie states that there is a marked shift to the left of the Arneth count in malarial fever not only during the attack, but also before its onset and for a considerable time after convalescence is established. The hemoglobin is reduced and granules of pigment are found in the plasma.

Clinical Varieties.—Besides the typical attacks *mild* or *rudimentary* forms are met with, these either being due to slight infection or appearing as the remnant of cases of usual severity after active treatment. The separate stages of the febrile attacks are not well marked, and one or more may be missing; thus the chill may be absent (dumb ague).

In *children* there is no rigor noticeable. They grow pale, the mucous membranes often being slightly livid during the chill, and the paroxysms may be initiated by a convulsion or other nervous phenomena. Acute nephritis is a rather frequent sequel in white children.

(II) **Pernicious Malarial Intermittent.**—This truly serious form occurs chiefly in highly malarial districts, and rarely also in the wide-spread regions in which the simple variety prevails. In the United States it is encountered most frequently in the Southern and Southwestern States. In this form of malaria the parasites of estivo-autumnal fever are constantly associated. The paroxysms do not recur with strict regularity, and the primary paroxysms are rarely pernicious in character.

¹ *Paris méd.*, Aug. 11, 1917, p. 129.

Pathology.—This type of malaria may arise (1) as a fresh infection and (2) as a reinfection.

(1) *Infection.*—The blood is more or less hydremic, and the blood-disks are in all stages of disintegration. The *spleen* is considerably swollen, soft, and its parenchyma is turbid and lake colored, all its tissue elements being more than naturally pigmented. Upon microscopic examination pigment granules and red corpuscles containing parasites and phagocytes are observed, particularly in the pulp adjacent to the arterioles. The *liver* is enlarged, soft, and turbid, and pigmentation occurs, but it also is microscopic. In the minute vessels phagocytes and parasites containing pigment are perceptible within the red corpuscles, and numerous small necrotic areas have been observed. The *kidneys* show microscopic pigmentation, most marked in the vicinity of its blood-supply. Minute areas of cell death are sometimes seen. The *brain* may be abnormally colored, assuming in severe cases a chocolate tint, and in mild types a lighter hue. The brain tissue is often anemic, and more rarely edematous. Occasionally there is congestion. The capillaries are literally blocked with phagocytes and blood-disks more or less disintegrated (containing parasites), and perivascular infiltration and minute hemorrhages may rarely occur, producing a focal lesion.

(2) *Reinfection.*—The blood is often extremely hydremic. The *spleen* may or may not be much enlarged, and is usually quite firm, with a well-marked pigmentation that is obvious to the naked eye. The *liver* is, as a rule, moderately increased in size, and is somewhat indurated, while macroscopically it is seen to be deeply pigmented. The changes presented by the *kidneys* differ in no essential manner from those of the liver. The microscopic appearances of the liver, spleen, and kidneys, apart from the fact that the amount of pigment present is relatively greater, are entirely analogous to those met with when a fresh infection occurs. Pigmentation of the lung is also common.

Clinical Varieties.—Three varieties merit description:

(a) *Congestive Chills (Algid Form).*—These are accompanied by raging gastro-intestinal symptoms (vomiting, purging, etc.), inducing systemic collapse, which simulates to a nicety the algid stage of cholera. The temperature of the interior of the body is much elevated. True dysenteric symptoms may arise, and sometimes jaundice, followed by grave nervous symptoms, may be a secondary development. The intellect is unclouded, as a rule. This condition is to be discriminated from yellow fever, with which it has frequently been confounded. The parasites in this affection center in a special manner in the gastro-intestinal mucosa, in the vessels of which they may be seen in unusual numbers, sometimes forming distinct thrombi. In the United States this is the most common among the pernicious forms.

(b) *Hemorrhagic Pernicious Malaria.*—In this form the chill is severe and prolonged, and during the hot stage the urine is bloody and scanty, containing considerable albumin, with bloody epithelial and granular casts. Hemorrhages from other outlets of the body (mouth, rectum, vagina, nares, stomach) may also occur, together with larger and smaller cutaneous ecchymoses, and the yellowish-brown malarial complexion is intensified. The mind may remain clear, although the patient is restless and anxious. Urinary suppression may ensue, and uremic toxemia be superadded; the greatest dangers being cardiac failure, uremia, and delirium (or coma independently of the latter). Death is rarely the direct consequence of hemorrhage. Brem believes this form to be due to a hemolysin produced by the malarial parasite.

(c) *Comatose Form.*—The chill may be absent. Grave cerebral symptoms, as acute delirium or sudden coma, seize the patient violently. The hot stage is attended with high fever, and if the patient survives the paroxysm,

the violent nervous symptoms either disappear suddenly with the appearance of the sweating stage, or may outlast the latter by several hours. Primary paroxysms rarely prove fatal, but recurrences bring imminent danger. This variety is due to an inordinate localization of the malarial parasites in the brain, where they form complete thrombi, and induce pathologic lesions in the adjacent structures.

(III) **Remittent or Continued Malarial Fevers (Estivo-autumnal Fever).**—On account of the intensity of the gastro-intestinal symptoms this variety is also termed *bilious remittent fever*. Its severity exceeds that of intermittent malarial fever. It prevails for the great part in warm and truly tropical climates, though it is also seen in its milder forms in temperate climates. The estivo-autumnal parasites previously described are the specific cause of the disease.

Pathology.—Melanosis of the spleen, liver, and brain is generally observed; on the other hand, in rare instances in which the specific parasite had even been demonstrated during life, the internal organs were found to be non-pigmented on autopsy. The degree of the pigmentation depends upon the length of time the patient has been infected, as well as upon the frequency of reinfection. The *spleen*, if it be a fresh infection, becomes swollen, but is soft; in protracted cases it becomes permanently enlarged and firm. Microscopically the pigment is seen to be most abundant in the splenic pulp and within and around the splenic veins. The *liver* is enlarged in like manner. The pigment that is found in the form of granular masses in all the hepatic tissue elements (especially Kupffer's cells, vessels, vessel walls, and perivascular tissue) gives to the organ a bronzed appearance ("bronze liver").

As in pernicious malaria, so in this affection, the *brain*, and particularly the gray matter, is in long-standing cases of a dark brown or almost black color. The *arterioles* are often found stuffed with phagocytes and blood-disks which contain pigmented parasites. Punctate hemorrhages may occur in the brain. The *kidneys* are pigmented and may show "a severe acute degeneration of the cortical tubule cells" (Ewing). Massing of the parasites in the renal capillaries may occur. Other organs and tissues of the body, including the *lymphatic glands and the skin*, become more or less deeply pigmented. The *blood* shows marked hydremia, with partly or wholly degenerated red blood-disks in abundance.

Symptoms.—There may be *prodromal* symptoms, such as headache, anorexia, and epigastric oppression, lasting a day or two, but these signs are variable. There may be daily or twice daily paroxysms of fever which resemble the ordinary quotidian and tertian and intermittent forms, with this difference, however, that the febrile paroxysms are of longer duration (twenty hours or more). Both the rise at the onset and the decline at the end of the paroxysm are more gradual than in true intermittent malarial fever, and the initial chill may even be wholly absent. The febrile attacks are often "anticipating," the succeeding paroxysms beginning before the elevated temperature of the preceding touches the normal level, giving rise to a remittent type of fever which often exhibits considerable irregularity. The remissions may become shorter, producing finally a continued type of curve—*continued malarial fever*.

In *typical cases* of remittent fever a chill generally occurs at the onset, but is less severe than in malarial intermittents. Shortly after the chill the temperature rises rapidly, so that in ten or twelve hours it may reach 104° or 105° F. (40°–40.5 C.). The *pulse* is full and accelerated to 100 or 120, and there is rending headache. Nausea and vomiting are common; oppression

in the epigastrium is intense, and there is well-marked tenderness in the latter region. The *spleen* is found to be enlarged on palpation. *Nervous symptoms* (delirium, coma, etc.) may develop speedily, and rarely a mild bronchitis may also arise.

DeBrun found amnesia a characteristic feature of malaria.

About midnight the *remission* in the temperature and sweating begin, in consequence of which the headache and gastric symptoms largely disappear. The *temperature* usually drops to 100° F. (37.7° C.) by the next morning, to be followed by a new exacerbation of fever, which commences about noon of the second day. The same symptoms now repeat themselves. The affection has usually by this time reached its acme, and the temperature may have risen to 106° F. (41.1° C.). Grave *nervous symptoms* may also have appeared. The *urine* is diminished in amount, often slightly albuminous, and acute nephritis is observed in 4.7 per cent. of the cases (Thayer); while either a slight or marked hepatogenous jaundice may appear. Urriola states that the presence of malarial pigment in the urine is a pathognomonic sign. A. C. Smith reports instances of bubo (inguinal) as a complication. *Herpes labialis* is quite common. The nocturnal remission again ensues, and in the *mild types* or in those brought promptly under suitable treatment the febrile paroxysms grow briefer, resulting in an intermittent form of fever. The course of light cases is run usually within two weeks.

In *severe types* or in neglected cases the separate febrile paroxysms grow longer until the remissions become slight and simulate continued fevers. These are the cases that are distinguished by the same symptoms as those that mark typhoid fever, save only the eruption and the Widal reaction. The course of the attack, if not properly treated, prolongs itself to three, four, or more weeks, and the salient features of the pernicious intermittent may suddenly appear and the disease may terminate life. On the other hand, *mild forms* of the continued type also occur, and these yield promptly to the specific—quinin.

(IV) **Malarial Cachexia.**—This is an exceedingly *chronic* condition, and is usually a remnant of one of the acute forms. When the latter are not properly treated they are apt to drag on and assume the characteristic features of chronic malarial cachexia. The condition may, however, be chronic from the start in truly malarial localities.

The *symptoms* are varied both in character and in intensity. There is *fever* at intervals, but chills do not occur, and the temperature-curve is typical neither of remittent nor intermittent fever, although it may approximate either the one or the other. Again, the fever is sometimes wholly irregular, though its range is not high, and it seldom exceeds 103° F. (39.4° C.). The *skin* often presents a dirty yellowish-brown complexion to a marked degree. The spleen is enormously enlarged and indurated, and hypertrophy with hardening of the liver may also be pronounced. The *blood* is profoundly anemic, the count in one of my cases showing but 1,300,000 red corpuscles per cubic millimeter.

Many of the local and general symptoms are dependent upon the well-marked *anemia*. Among *general features* may be mentioned debility, frequent sweatings, and dropsy. *Nervous symptoms* may also be noticeable, and chief among these are tremors, neuralgia, palsies, vertigo, wakefulness, and nervous palpitation of the heart. Among the rarest concomitants of this condition is paraplegia. *Malarial neuritis* is met with and presents most of the features common to other toxic forms of neuritis. Slight cough and dyspnea evidence the presence of mild *bronchitis*; and anorexia, nausea, diarrhea, and other symptoms of *chronic gastro-intestinal catarrh* are observed. The joints

and voluntary muscles may be painful. *Hemorrhages* from the various mucous surfaces and into the retina are common; and I have seen one case in which spongy, bleeding gums, with numerous petechiæ, pointed to the existence of associated scorbutus. *Tuberculosis* finally developed and carried off the patient. *Chronic dysentery, fatty degeneration of the heart, and chronic nephritis* may develop and prove serious sequelæ. These cases do well, generally, if the patient can be removed permanently from the malarial district. In long-standing cases the spleen does not return to its natural dimensions. Complete recovery, however, may be expected.

(V) **Masked Intermittent.**—This presents itself in much the same forms as chronic malarial cachexia, but with the important difference that there is no fever. This type comprises a long list of conditions, at the head of which stands *neuralgia*, most frequently involving the supra-orbital branch of the trigeminus. Often a striking periodicity is observed, the painful paroxysms usually beginning in the morning and terminating in the late afternoon hours, the patient's sufferings increasing steadily in intensity until just before the close of the attack, when they suddenly abate. Among other nerves implicated with relative frequency are the occipital, the intercostal, and the sciatic. Except the blood appearances be characteristic or unless the attacks yield promptly to quinin, a certain diagnosis of malarial neuralgia should not be ventured. Craig, out of 395 cases of latent and masked malaria, found the estivo-autumnal parasite in 275; they appeared as a small hyaline disk or ring-form within the red blood-corpuscle. The parasites, however, have been observed in all stages of growth, even undergoing segmentation. Craig believes that the latency can be accounted for by the fact that the few organisms present do not generate sufficient toxin to provoke characteristic symptoms. Masked intermittents may assume the forms of paresthesia, anesthesia, convulsions, or paralysis; they may also appear under the guise of edema, hemorrhages from the various mucous outlets of the body or into the skin, diarrhea, dysentery, dyspepsia, bronchitis, pneumonia, appendicitis, etc. But, since these affections may all obey the law of periodicity, we should not pronounce in favor of malarial infection unless they yield readily to the therapeutic specific, or the parasite is found.

(VI) **Malarial Hematuria and Hemoglobinuria.**—I have previously described a hemorrhagic form of pernicious intermittent in many cases of which hematuria is a prominent symptom. Boisson, in 3 cases of hemoglobinuric fever occurring in soldiers attacked with malaria in Madagascar, found great reduction in the erythrocytes, while 7 out of 10 red cells contained parasites. I have observed several instances of malarial hematuria in the Kensington district of Philadelphia, where the milder forms of malaria prevail. Hematuria in its severest form is seen with the approach of cold weather (Jones). It is rare in the negro. Young in both sexes and males over puberty are most apt to suffer. The blood shows pigmented parasites (forming rosettes), and sometimes crescents and pigmented leukocytes.

The symptoms consist of a mild cold stage, a subfebrile temperature to which is added hematuria, or more often hemoglobinuria. The paroxysms may recur daily, twice daily, or at longer intervals, and in severe forms the hemoglobinuria may be continuous, with aggravations at definite intervals. Suppression of urine may appear early accompanied by uremic features, *e. g.*, coma, nausea, vomiting, diarrhea. The lumen of the renal tubules may be occluded by plugs of granular material derived from the hemoglobin. The diagnosis demands the demonstration of the malarial parasites in the blood and of the hemoglobin in the urine. Tyson recommends Teichmann's (hemin crystals) test

to show the presence of hemoglobin. The earthy phosphates are precipitated, filtered out, and a small portion placed on a glass slide and carefully dried. A minute granule of common salt is carried on the point of a knife to the dried mass and thoroughly mixed with it. Any excess of salt is then removed, the mixture is covered with a thin glass cover, a hair interposed, and a drop or two of glacial acetic acid allowed to pass under. The slide is then carefully warmed until bubbles begin to make their appearance. After cooling, hemin crystals can be seen by the aid of the microscope, and are easily recognizable by an amplification of 300 diameters. Chemically, they are hydrochlorate of hematin.

The so-called "blackwater fever" is an intoxication due to repeated attacks of malaria in which "some exciting cause produces a sudden hemolysis" (Prout), and quick spontaneous disappearance of the malarial parasites (Plehn). Other observers (Sambon, Macay) regard hemoglobinuria as a specific disease. Bass and Johns found that calcium salts added to culture-mediums caused hemolysis of the infected as well as the non-infected cells of the blood of the sufferer. The leading characteristics are irregular paroxysms of fever with rigor, bilious vomiting, jaundice, hemoglobinuria, and nephritis. This form occurs in the Philippines, in Germany, and other countries.

According to Frank A. Jones, obesity occurs among persons coming from a climate free from malaria to the Mississippi's delta. They neither have chills nor manifestations of chronic malaria. "The obesity subsides rapidly by changing from a malarious to a non-malarious climate."

Complications.—The author's analysis of 1780 cases of malaria (intermittents and remittents) showed complications in about 10 per cent. The more common among these were: Enteritis (16), nephritis (14), rheumatism (10), typhoid fever (8), lobar pneumonia (5), jaundice (5), and dysentery (4). The opinion of the profession is divided upon the question: "Has pneumonia any special connection with malaria?" According to the results of my collective investigations pneumonia is rarely associated. Craig affirms that malaria may present typical symptoms of pneumonia, probably owing to a localization of the malarial parasite in the capillaries of the lungs. Thayer's studies show that the frequency of albuminuria and nephritis in malarial fever is somewhat below that observed in the more severe acute infections.

Typhoid fever is a complication of malaria according to these researches, but the relationship between these affections cannot be close.

Diagnosis.—(1) **Of Intermittents.**—This is difficult unless the brief febrile paroxysms, with their characteristic stages and other diagnostic features (enlarged spleen, malarial complexion, herpes), together with the rigid periodicity of the paroxysms, be present. Residence in a malarial district is confirmatory. The only unquestionable method of diagnosis is provided by a microscopic examination of the fresh blood. If this cannot be made, an early diagnosis is rarely possible until the peculiar manner of recurrence of the paroxysms is established.

DIFFERENTIAL DIAGNOSIS.—Non-malarial affections, exhibiting an intermittent form of fever, are often mistaken for malarial intermittents. Of these, (a) *pyemia* is very apt to be thus confounded. It will be observed, however, that the chills occur at more irregular intervals, and that prostration is more profound during the intervals between the febrile exacerbations. The etiologic factors and place of residence are also to be considered. The blood should be examined microscopically, and, if this be impossible, the therapeutic test will, as a rule, remove any doubt. *Leukocytosis* is common in *pyemia* and absent in malaria.

(d) *Acute tuberculosis* and, more rarely, *incipient chronic tuberculosis* may present a febrile movement in no way differing from quotidian intermittent, except that in the former the pyrexia develops in the afternoon instead of the forenoon, as in the latter. A clear history, the associated local and general symptoms, along with the results of a careful physical examination, usually render tuberculosis probable and distinguish it from malarial intermittents. In tuberculosis the chills recur despite the use of quinin, but this is not the case in malaria.

(c) *Ulcerative endocarditis* may exhibit an intermittent pyrexia, but the history is different, and the associated features are more numerous and decidedly more grave. A blood examination reveals leukocytosis—a distinguishing feature. Again, quinin is without effect. The irregular forms of intermittents are difficult in the extreme to diagnosticate. If in suspected cases of “erratic” malaria quinin is resisted, we cannot feel certain of our diagnosis unless we obtain the microscopic evidence of the presence of the malarial parasite in the blood.

(2) The diagnosis of **remittent fever** would be easily made if it did not sometimes bear a strong resemblance to typhoid fever. Its certain recognition demands the detection in the blood of the estivo-autumnal parasite. In *typhoid fever* the history points to a more gradual onset, the remissions are less marked, and epigastric oppression is wanting. Again, typhoid has its characteristic eruption and gives the seroreaction. (For diagnosis from hepatic abscess, *vide* p. 885.) Trench fever may closely simulate malaria.

Method of Examining the Blood for the Malarial Parasite.—The finger or lobe of the ear is carefully cleansed, and then slightly cut with a sharp lancet. The first drop of blood is wiped away and the second collected on the center of a clean cover-glass, which is immediately placed upon a clean slide and the blood allowed to spread in a thin film, and examined immediately through an oil-immersion objective. It is all-important that the blood be perfectly spread between the surfaces of the slide and cover-glass in order that the corpuscles do not rest one against the other. In the fresh specimen one is able to detect the parasite during all its developmental stages seen in man, but the best time is either just before or during the chill. If the blood of estivo-autumnal fever be exposed to the air a short time and then mounted in this manner, it is likely to display flagella. If desirable to preserve the specimen, or if impossible to make the microscopic examination at once, smears should be prepared by laying another cover upon the first, allowing the blood to spread in a thin layer, and then sliding them apart quickly and drying in the air. If permanent specimens are desired, Wright’s modification of Romanowsky’s stain is to be preferred. The specimen should be covered with the solution and allowed to stand two minutes. To stain, add 3 to 4 drops of distilled water and allow to remain two or more minutes, when the specimen is washed with water, dried, and mounted in Canada balsam. The organisms appear as small blue bodies, often containing pigment. If the thin film fails to reveal the parasites in a suspected case of malaria, they may frequently be discovered by making a thick film. James’ method of so doing is extremely satisfactory: Spread a drop of blood in a $\frac{3}{4}$ -inch circle, dry, place in a solution of 50 c.c. ethyl alcohol to which has been added 0.5 c.c. hydrochloric acid until hemoglobin is dissolved, wash in running tap-water for fifteen minutes, stain with Romanowsky’s stain, wash, and examine. Bass and Johns have devised a method of concentrating the crescents by centrifuging the blood containing them at a high speed. Dr. Marchoux states that in the Salonika type the microscope reveals the parasites two or three days before the onset of fever.

Prognosis.—Uncomplicated cases of intermittent fever under proper

treatment generally recover. In certain malarious regions and seasons pernicious types prevail. *Primary pernicious attacks* are moderately dangerous, while recurrences are highly so. The mortality rate in this variety is between 20 and 25 per cent. In *remittent fever* death may be due to asthenia, particularly when the type is severe and when wrong notions as to treatment prevail. Suppression of urine, followed by uremic symptoms, hemorrhages, and jaundice are grave complications. Early vigorous treatment of all forms is indicated, since the older the asexual cycle, the more resistant to quinin and the greater the danger of a relapse. Out of 2460 cases studied by Ross, 27 per cent. relapsed either during treatment or afterward.

Treatment.—**PROPHYLAXIS.**—The investigations cited above show that an individual ill of malaria is a source of danger in a community, and should be promptly protected from mosquitos, and then treated. The homes, and more particularly the sleeping apartments, of persons residing in paludal regions should be protected against invasion by mosquitos. The use of wire netting is to be advised for this purpose. Caps to which the same material is attached may be worn out of doors. Methods for destroying the mosquito (adult female and larvæ) should be adopted. In rooms this is best accomplished by fumigation; in the outer world the breeding-places (*e. g.*, marshes) must be found and then removed by thorough drainage, and by covering water-barrels and privies. The larvæ are most effectually suffocated by sprinkling petroleum upon the water, to the surface of which they rise to get air. Wickliffe Rose¹ recounts briefly the extensive field experiments in malaria control carried out by the International Health Board. He shows that malaria control by antimosquito measures in a region with a reasonably high infection rate is practical and feasible; in heavily infected districts malaria may be held in bounds by proper screening, immunizing doses of quinin, and the destruction of the parasites in the blood of carriers by quinin.

Koch states that gametes are often found in children and that many persons harbor the parasite without manifesting active symptoms; he advises prophylactic doses of quinin in malarial localities. Bass holds that as the anophles disappears during the winter months, man must act as a carrier during this period. For this reason he recommends that quinin should be taken by all inhabitants of infected localities during the winter for two successive days of the week for six weeks. After infection the presence of the parasites may be discovered two or three days before the occurrence of the fever and the patient completely sterilized at this period by the use of quinin.

1. For **intermittent malarial fever** there is an almost infallible remedy in quinin. "When shall its use be commenced?" is a pertinent question. It would certainly seem highly desirable to check the course of the disease as soon as possible, and especially since transition of the simple intermittents into the pernicious forms may occur if the disease be not arrested. At the present day specific treatment is often delayed in order to give full opportunity for making a blood examination with a view to completing the diagnosis. There is no decided advantage in commencing the use of quinin during the first paroxysm, when the blood may be examined; but on finding the case to be one of malaria, quinin should be administered after the paroxysm, so as to prevent a recurrence. On the other hand, if there is no opportunity to examine the blood microscopically, the principal antiperiodic remedy should be commenced at the close of the paroxysm. The quinin cures malaria by acting directly upon the intracorpuseular hematozoa (the young forms).

During the *paroxysm* we should aim to make the patient comfortable. He is to remain in bed, is to be well covered, and external heat applied during

¹ *Jour. Amer. Med. Assoc.*, 1919, lxxiii, 1414.

the cold stage; and he is to be lightly covered, giving cooling drinks and cold spongings during the hot stage.

During the *apyrexial intervals* the patient may leave his bed provided that he feels strong enough, and, as before intimated, the specific remedy is given during the afebrile period. Certain authors recommend that the entire daily quantity be given at one dose from four to six hours before the succeeding paroxysm is expected, the object being to surcharge the blood at the time when the hematozoa sporulate. The total amount per day required to destroy both the asexual and sexual parasites is from 15 to 20 grains (1.0–1.3) for a period of three weeks, in most temperate climates. When this fails, more may be given—24 to 30 grains (1.5–2.0). My own practice has been to administer immediately after the close of the sweating stage, gr. iv or v (0.25–0.3), repeating the same dose a few hours later, and the remaining 8 or 10 grains (0.5–0.6—or one-half the daily dose) six hours before the time for the next paroxysm. I have thus escaped the slight toxic symptoms (tinnitus, deafness, nausea, etc.) which are apt to follow single large doses. The remedy should be administered in the form of the hydrochlorid, in capsules. After the attacks cease to recur quinin should be continued in amounts of 6 to 8 grains (0.4–0.5) daily for several days. If quinin cannot be taken *per os* it may be tried by enema or by suppositories in appropriately large doses. In young subjects I administer the quinin by suppository. The large number of cases of malaria seen in Panama and the splendid results that have been achieved there make it worth while to record the routine treatment practised there by the United States Army physicians. Ashford, quoting from James, outlines the method of routine treatment as follows:

"1. A preliminary purge of 3 to 5 grains (0.2–0.3 gm.) of calomel, followed in twelve hours by 2 ounces (60 c.c.) of a 50 per cent. solution of magnesium sulphate.

"2. An initial dose of 20 grains (1.3 gm.) of a liquid preparation of quinin, best made by adding a drop of hydrochloric acid to every 5 grains (0.3 gm.) of quinin dissolved in 5 c.c. of distilled water.

"3. Doses of 15 grains (1.0 gm.) of quinin in this same form three times a day for a week or until the temperature has been normal for from five to six days.

"4. A subsequent reduction of this dose to 30 grains (2.0 gm.) a day for ten days more.

"5. When after this treatment there are relapses, use 1 to 2 gm. of quinin in 300 to 500 c.c. of normal salt solution intravenously on two successive days and then continue with 45 grains (3.0 gm.) a day by mouth."

Bates, commenting on this plan, writes that the average daily dose is about 30 grains (2.0); grave cases should receive 40 to 45 grains (3.0–0.0) daily for ten days, returning then to the smaller dose, while in pernicious forms 60 to 90 grains (4.0–6.0) may be given in twenty-four hours, again returning to the smaller dose after the first day.

The physiologic effects of the drug can be quickly obtained by administering it hypodermically. Hence, if there be no time for absorption from the intestine (four hours being the shortest period it is safe to allow), the drug should be thus employed. For this purpose the more soluble salts (hydrobromid, hydrochlorid) of quinin are to be preferred to the ordinary and more insoluble sulphate. Ross, on the other hand, does not believe in quinin hypodermically. He claims that it is not as well absorbed as when given by the mouth. In other words, if oral administration is not indicated the drug should be given intravenously. Alport,¹ as a result of a very large experience with

¹ *Malaria and Its Treatment*, Wood & Co., 1919.

the British Army on the Salonika peninsula, has come to the conclusion that intramuscular injections should be employed in the following types of cases: (1) with severe exhaustion, cachexia, anemia, jaundice, and apyrexial malarial infection, (2) blackwater fever, (3) when the patient has a thickly furred or dry brownish tongue, quinin by mouth not being absorbed, (4) with a temperature over 104° F., (5) with vomiting, and (6) with mental symptoms. He says, however, that the intravenous injection is, without doubt, the soundest and best method of administering quinin. In addition to the indications for hypodermic injections, for which the intravenous route is in truth superior, this latter method should always be used in cases with marked mental or nervous symptoms and cases with all types of pernicious malarial fever.

Occasionally individuals are met with who have an idiosyncrasy to quinin. O'Malley and Richey¹ show that such cases show a marked skin reaction as an evidence of their sensitiveness, and that in some cases they may be desensitized by giving 0.005 gm. of quinin with 0.5 gm. of sodium bicarbonate. Ninety minutes later 0.1 gm. of quinin and sodium bicarbonate is given. The preliminary dose remains constant, while the second dose is daily increased 0.1 gram.

Many preparations of cinchona other than the salts of quinin may be tried, and among these cinchonin administered in the same manner as the latter is the best substitute. Some contend that the sulphate of quinidin has antiperiodic power almost equal to quinin. In prolonged cases the salts of quinin and other preparations of cinchona sometimes lose their specific influence, the parasites apparently becoming "quinin fast," that is, resistant to the effects of the specific drug. Arsenic is then to be employed either alone or in combination with the former agents. The dose of the arsenic, beginning with griv (0.26) t. i. d. of Fowler's solution, must be increased until its physiologic effects are produced. Arsenous acid often does even better service than Fowler's solution. Administered as above indicated this remedy is most efficacious in malarial cachexia and masked forms of intermittents; it may be combined with iron and quinin. Atoxyl, either alone or associated with quinin, is capable of bringing about rapid improvement in health, especially in cachexia and chronic forms of malaria. Werner recommends arsphenamine (0.6–0.7 gm.) in cases in which the parasite is resistant to quinin. Cowan and Strong² contend chronic cases of malaria are not cured by huge doses of quinin, but, on the contrary, many cases are hurt by it on account of the debility it produces. Arsenic is the drug that really should be employed in such cases. It is essential that it be used in all chronic cases. While in charge of the outpatient service of the Episcopal Hospital, Philadelphia, I employed in malarial cachexia, with satisfactory results, the sulphate of cinchonidin in daily doses of gr. xxx to xl (2.0–2.5). Splenectomy has been recommended in intractable forms; but Klemperer holds that it does harm rather than good in this disease.

2. The Treatment of Pernicious Intermittents.—(a) *Prophylaxis.*—By treating all ordinary intermittents actively after the first paroxysms the occurrence of pernicious forms can be obviated. Not to pursue this course in malarial seasons and localities is next to criminal.

(b) The *first pernicious attack* must be treated immediately, and there is not a moment to be lost. Hence in all varieties of pernicious intermittents quinin should be administered hypodermically until the patient is fully cinchonized—a condition that must then be maintained for several days. C. C.

¹ *Arch. Int. Med.*, 1919, xxiv, 379.

² *Quart. Jour. Med.*, 1919, xiii, 1.

Bass¹ holds that the proper specific treatment of malignant malaria is quinin administered intravenously. The dose should not exceed 10 grains (0.65) of the hydrochlorid, and not more than 30 grains (2.0) should be given during the twenty-four hours. In all varieties stimulants are to be used freely if the heart's action becomes feeble, and the patient is to be well nourished throughout. There are other details, though of relatively minor importance, and they vary with the individual forms. Thus in "congestive chills" external warmth is useful, and morphin combined with atropin should be given hypodermically, this combination tending to allay gastro-intestinal symptoms as well as to warm the extremities, and meeting really important indications. Rectal feeding must be resorted to should the stomach refuse to retain nourishment. In the *comatose form* the nervous symptoms are most successfully combated by prompt and energetic antiperiodic treatment, together with vigorous stimulation and feeding, since they are due to the intensity of the infectious process.

(c) During the apyrexial period every effort must be made to prevent a recurrence of the paroxysm, and to this end the patient must be kept fully cinchonized until the time for the next paroxysm is over.

3. Treatment of Remittent Fever.—The mode of treatment in this form differs somewhat from that appropriate for intermittents. At the onset a mild mercurial is advantageous (calomel, gr. $\frac{1}{4}$ —0.016, every hour for three doses), followed by a saline laxative (Rochelle salts, \mathfrak{z} ij—8.0). During the febrile exacerbations cool spongings of the body, coupled with the use of the ice-cap, are serviceable. The gastric symptoms demand chipped ice by the mouth or small doses of cocain, and a mustard plaster externally. Immediately after the first remission sets in quinin must be exhibited, and large doses are now indicated (gr. xv—1.0, to be repeated at 8 or 9 A. M.). A third and even a fourth dose of the same size may be required. The exacerbations of fever generally yield to this remedy, but if, as rarely happens, they do not, then small doses of pilocarpin (gr. $\frac{1}{8}$ to $\frac{1}{6}$ —0.008–0.010) may be administered hypodermically during the height of the fever. This causes free sweating in many instances, and in consequence renders the remission more marked and more prolonged; thus in short, rendering the course of the affection speedily favorable. The heart must be guarded.

A case that has been allowed to run on for one, two, or more weeks is often greatly benefited by the use of Warburg's tincture for several days, when quinin may be re-employed. The patient, especially if the case be protracted, must be vigorously fed, and *per rectum* if it cannot be accomplished by the mouth. In typical cases, which are promptly controlled by quinin, stimulants are rarely needed, or at least not until the convalescent stage is arrived at. In severe and neglected cases the indications for their employment may be presented early, and they should then be given, the physician conforming to the same rules as in typhoid and other acute infectious diseases. The renal congestion and anuria are to be met by internal diaphoretics (pilocarpin, etc.) and by saline laxatives. Most efficacious, perhaps, is a combined hot-water and steam bath. The patient is placed in hot water, and then a blanket is put around the neck, its free ends being allowed to extend over the edges of the tub.

4. Treatment of Malarial Hematuria.—Whether or not quinin is to be employed in hemorrhagic pernicious malaria is a question involved in doubt. The statistics of M. Brady indicate a tremendous advantage in discontinuing quinin as soon as blood shows in the urine—a reduction of mortality from

¹ *Jour. Amer. Med. Assoc.*, August 14, 1915, p. 577.

distoma. An endemic form occurring in Japan has been described; it is characterized by marked emaciation, diarrhea, hepatic enlargement, and often by ascites.

The prognosis of *Distoma hepaticum* is absolutely fatal, and the treatment is merely palliative, though it may run a course extending through many years, often with intermissions, even apparent recovery, later to relapse. The removal of the fluke from the liver of its usual host (cattle) has been reported by numerous authorities, who have employed for this purpose ethereal extracts of male fern or kamala.

Among other trematodes may be mentioned: (a) *Distoma lanceolatum* (found also in cattle); (b) *D. crassum*, which is larger in size than the preceding; (c) *D. sibiricum*; (d) *D. pulmonale* (*D. ringeri*); (e) *D. spatulatum* (endemic); (f) *Amphistomum hominis*; (g) *Distoma hæmatobium* (Bilharz). Two of these deserve extra, though brief, mention.

Parasitic Hemoptysis (*Distoma Pulmonale*).—This is caused by the *Paragonimus westermanii*, first described by Manson (1880) and Baily (1880) in man. The lung fluke-worm has also been found in the tiger (originally by Kerbert), hog, dog, and cat. The disease is extremely prevalent in certain provinces of Japan and China. Elsewhere it is usually mistaken for pulmonary tuberculosis. Stiles and Hassall have discussed the whole subject. The parasite is 8 to 16 mm. long, 4 to 6 mm. broad, and 2 to 5 mm. thick. It is found encysted, usually two individuals in each cyst, with eggs, and its habitat is the lungs of mammals. It enters its final host (man, etc.) either encysted or as a free-swimming cercaria. *The mode of infection*: Eastern writers look upon the drinking-water supply as the source of infection, and this view has much in its favor. The disease has been found in hogs throughout various sections of the United States by Stiles; this suggests the possibility of widespread infection in America.

Predisposition.—Most cases occur between the ages of eleven and thirty years. Out of 58 sufferers, 38 were farmers (Stiles).

Symptoms.—In the usual form (lung infection) cough is common but not constant; the sputa are similar to those of lobar pneumonia, although they may be absent from time to time. Free blood-spitting often occurs at intervals. Jacksonian epilepsy may supervene from metastasis to the brain.

Diagnosis.—This rests upon the detection of the eggs in the sputum. Place a drop of the bloody sputum on a slide, and upon it a cover-glass. On microscopic examination the red color will be found due to both red blood-cells and large dark brown, thick-shelled, operculated ova, which vary from 80 to 100 μ in length and from 40 to 60 μ in breadth.

The prognosis depends upon the number of the parasites present, the age of the patient (the young and the old bearing the disease badly), and the presence or absence of complications. Pulmonary tuberculosis is an unfavorable complication.

Treatment.—Prophylaxis embraces care regarding the drinking-water, and the collection and disinfection of the sputum, as in pulmonary tuberculosis. The patient should be sent to healthy non-infected areas. There is no special medical treatment.

Distoma Hæmatobium (*Bilharzia hæmatobia*; *Blood-flukes*).—This trematode is a narrow worm with anterior abdominal sucking-disks. The male is shorter and thicker than the female; the former being 4 to 15 mm. ($\frac{1}{2}$ in.) long; the latter, about 20 mm. ($\frac{4}{5}$ in.). It prevails mostly in Egypt, Cape Colony, and other parts of Africa, and its entrance into the human body is now believed to be through the skin of those who bathe frequently in the

and may themselves give rise to other or granddaughter cysts in a similar way. These really become the breeding capsules of little cellular outgrowths that form the scolices or heads of future teniæ. They show the four sucking disks and a circle of hooklets. Each scolex, when taken into the intestine of the dog, develops into an adult bladder-worm or *Tænia echinococcus*. This endogenous mode of cystic growth is common in man (*Echinococcus hydatidosus*). In animals the so-called exogenous cyst development is the more common, in which the primary cyst-buds push out between the cyst wall and then develop externally. A third variety is the multilocular echinococcus (*Echinococcus alveolaris*, Buhl), affecting principally the liver. A large, hard tumor is seen that on section shows a firm connective-tissue framework surrounding alveoli that average a small pea in size. These alveoli contain small echinococcus cysts with thick, laminated walls. They may contain scolices or hooklets, and sometimes they are sterile. The echinococci may be situated in the lymph-channels and bile-ducts (Zenker).

The pure hydatid fluid is colorless, limpid, neutral in reaction, and has a specific gravity of 1005 to 1012. About 96 to 98 per cent. is water, and sodium chlorid, carbonate, and sulphate; traces of sugar (dextrose); cholesterin and uric acid are found among the constituents.

Among the changes that an echinococcus cyst may undergo the commonest is that of the *death of the echinococci*, as from diminished nourishment due to intense proliferation of daughter and granddaughter cysts. The contents become thickened, putty-like or granular, and even calcified. Remnants of these obsolete cysts, such as the chitinous substance of the old and outer wall layer and hooklets, may be found. Sometimes *rupture* of the cyst occurs, with serious consequences to the patient; or the peritoneum daughter cysts or free scolices may be disseminated and grow. Or *perforation* into the respiratory, digestive, or urinary tracts and discharge of daughter cysts and hydatid fluid may take place. Lastly, *suppuration* and the formation of large hepatic abscesses may ensue, either spontaneously or on account of septic instruments used for tapping the cysts.

Etiology.—Carelessness in the feeding and the keeping of dogs is the primary source of hydatid disease, and the preparing of food where dogs are allowed to roam about, and so on, accounts for the majority of cases. Females are more often affected than males, and children and young adults seem to be oftener affected than those older in years.

As regards the *geographic distribution*, echinococcus disease prevails most extensively in Iceland, where man and dog live closely together. In Australia, also, many persons are affected. It is not so common in Europe, Asia, or Africa, and in America it is rare.

Organs Affected.—*Tænia echinococcus* has an undoubted predilection for the liver. "Of 1806 organ infections, the following organs were the most frequently affected: liver (1011), lung (147), and kidney (126)" (Stiles). The brain and spinal cord, spleen, bones, muscles, the heart, and blood-vessels are involved with uncertain frequency.

Symptoms.—**Hydatids of the Liver.**—Unless the cystic tumors compress the portal area or the biliary passages, or invade the neighboring viscera, subjective symptoms may be entirely wanting. Not infrequently echinococcus sacs, partly calcified, have been found *postmortem*, not having produced any symptoms during life. Gradual but progressive loss of flesh and strength with the presence of a fluctuating tumor may be the only symptoms present until late in the disease. If the cysts attain a large size, a sensation of dragging and of pain even is often present; as a rule, however, pain is absent throughout the course of the disease. If the tumor displaces the diaphragm upward and

compresses the lung, cough and dyspnea result. In some cases the sac has ruptured into the bronchi, and given rise to cough and to expectoration of the fluid and vesicles.

If the portal veins and bile-duct are compressed, splenic enlargement from passive congestion, ascites, and jaundice will occur, these symptoms being more common when the cysts are multilocular. Rupture may occur into the intestines (colon), into the pleura or pericardium, causing pyothorax or pyopericardium, or into the inferior vena cava, causing fatal pulmonary embolism.

Fever is usually absent throughout, unless the contents of the sac become converted into an abscess; then rigors or chills, fever (hectic in type), and sweatings occur, with jaundice (more or less intense) and rapid emaciation.

Not infrequently the cyst wall becomes partly calcified and the contents are reabsorbed.

When rupture occurs, unless the contents be evacuated through the respiratory, alimentary, or urinary tracts or externally, symptoms of collapse develop and are followed by death. Toxic erythema or urticaria may follow rupture of the cyst.

The **physical signs** give on *inspection* fulness or bulging in the right hypochondriac region, especially if the cyst be single, of large size, and situated anteriorly.

Palpation confirms inspection and shows a fluctuating mass or masses. A trembling impulse is felt sometimes on deep palpation aided by light percussion over the opposite side of the cyst, constituting the so-called "hydatid thrill." This sign cannot always be elicited, but when present is pathognomonic of the disease. The remainder of the liver shows uniform enlargement. The spleen is often palpably increased in size from passive congestion.

Percussion reveals an increased area of dulness to the left or posteriorly, depending on the location and extent of the growths. If the left lobe be involved, the line of flatness may extend across the sternum to the left hypochondriac region. If the cysts are multiple and on the antero-inferior surface, the stomach may be displaced toward the left and dulness may extend across the epigastrium; if posteriorly, the pleural cavity may be encroached upon, causing an increased area of flatness upward in the postero-axillary line. Frericks claims the line of dulness posteriorly in hydatid disease to be a curved one, whose convexity is upward.

Auscultation gives, according to Santoni and others, a short, sharp booming sound when the tumor is percussed that may be likened to one produced by striking a membrane stretched over a metallic frame.

Diagnosis.—In the entire absence of subjective symptoms and of characteristic physical signs, the diagnosis is impossible. If the cyst be of sufficient size to give fluctuation and the liver be irregularly enlarged, with an absence of fever, pain, and marked emaciation, the disease may be strongly suspected. The only certain demonstration of the condition is the discovery of the characteristic hooklets or heads in the aspirated or discharging contents of the cyst. Abrikosoff¹ advocates serodiagnosis of echinococcus disease. Zapelloni found a positive response in 93 per cent. of 500 cases compiled from the literature, while eosinophilia was manifest in only 60 per cent. The blood shows a pronounced eosinophilia, due to the toxic influence of the echinococcus. Among the conditions that may be misdiagnosed for hydatid disease are: (a) Dilatation of the gall-bladder, (b) hydronephrosis, (c) right-sided pleurisy with effusion, (d) syphilis of the liver, (e) carcinoma, (f) abscess, and (g) cirrhosis.

¹ *Medizinskoe Obozrienie*, Moscow, 1913, lxxix, No. 6.

HYDATID CYST

Previous history negative, except the companionship of dogs.
Pain and jaundice usually absent.

Enlargement in any direction, depending upon the location of the cysts.
Hydatid thrill may be present.
Less so.

HYDATID CYST

The history is negative (*vide supra*).

Urinalysis is negative.

The tumor is most prominent over the hepatic area, and is associated with enlargement of the liver.

The duration is indefinite and uremia rare.

HYDATID CYST

The onset is slow; pain and fever are absent.

The presence of a fluctuating mass in the hepatic area, *not changing with the position of the patient*. Hydatid fremitus is present, but no bulging of the intercostal spaces.

Aspiration reveals a clear yellow liquid of low specific gravity without albumin, but chlorids, sugar, and hooklets.

The disease invariably runs a chronic course.

DILATATION OF THE GALL-BLADDER

A previous history of having passed biliary calculi is often present.

Attacks of biliary colic followed by jaundice either are present or enter into the previous history.

Enlargement is always in one direction—downward and posteriorly.

"Hydatid fremitus" never present.

The tumor is somewhat movable.

HYDRONEPHROSIS

There is a history of renal calculi or of vesical inflammation.

Reveals evidences of renal disease.

The tumor is most prominent in the flank and iliac fossa. If extending to the right hypochondriac region, it *does not* move with the liver.

The duration is short; a termination in uremia is common.

PLEURISY WITH EFFUSION

The onset is sudden, and violent pain is present, with fever and dyspnea.

The presence of effusion, beginning at the base of the chest and gradually extending upward—*changing with the position of the patient* and accompanied by bulging of the intercostal spaces.

Aspiration gives a cloudy, turbid liquid, containing albumin and flakes of lymph with high specific gravity.

The disease generally runs an acute course.

For a differential diagnosis from (*d*), (*e*), (*f*), and (*g*) I would refer the reader to the discussion of the several diseases (*vide Diseases of the Liver*).

Echinococcus of the Respiratory Organs.—The lung has been the seat of the larvæ frequently, and instances have been noted in North Germany and Australia. The right lower lobe has been the seat of predilection, though sometimes the pleura. There are pain in the chest, cough, dyspnea, perhaps arching of the overhanging thoracic region, signs of a pleural effusion, a tympanic note above the prominence, hemoptysis, and the pathognomonic expectoration of hydatid disease. The general condition may or may not be seriously affected. Perforation into the pleural sac by pulmonary echinococci may be followed by empyema, and later by perforation of the chest wall. The heart may be dislocated. Compression of the lung may produce gangrene.

The *diagnosis*, in the absence of the characteristic sputum, is to be made from phthisis and a pleural effusion. Their location at the base of the chest may serve to differentiate hydatid cysts from phthisis, as well as the absence of marked emaciation. The characteristic curved upper boundary of dulness in pleural effusion and the change of the boundary upon changing the patient's position will serve to distinguish this affection. Pleural echinococci sometimes cause great compression of the lung and a barreling of the chest on one or both sides. The pain may be quite sharp, and the respiratory murmur either distant or altogether absent.

Echinococcus of the Mediastinum.—Hare has collected 6 cases of hydatid disease among 520 cases of mediastinal tumors.

TENIÆ OR TAPEWORMS

Natural History.—Tapeworms are found in the intestine of man, and are the matured or completely developed larvæ or cysticerci from the muscles and solid viscera of animals. Different varieties of cysticerci develop from the ova of the respective varieties of teniæ. These tapeworm eggs, after having passed out of the bowel, may be taken into the systems of various animals by various modes, entering the circulation, it may be, and becoming fixed within the solid tissues, especially the muscles. In about two or three months pea-sized cysts develop, and from the cyst walls there gradually forms a new tenia head, called a *scolex*, or nurse. The worm-cysts, popularly termed “measles,” constitute the cysticerci. Remaining in the tissues, they die and become calcified in from three to six years (Strümpell). But if taken into the stomach by the eating of raw or partially cooked meat a tapeworm develops from the scolex. The maturation of the segments of the tapeworm commences several months after the fixation of the scolex in the intestine. In the natural life-cycle of a tapeworm the usual order of lodgment may be reversed. Thus man instead of a lower animal may become the host of the tenia eggs, which, in turn, may find their way into the solid viscera and muscles to develop into cysticerci. Again, this same order may be brought about by “auto-infection.” The tapeworm has a ribbon-like form; although it has a number of segments and joints, giving it a link-belt appearance. When matured these segments, or *proglottides*, develop male and female generative organs.

Varieties.—*Tænia Solium* (*Pork Tapeworm*).—This worm is rarer in America and also in Europe than formerly. It develops in the small intestine after the ingestion of raw or underdone “measly” pork. This worm does not necessarily exist singly, as its name would indicate, although such is usually the case. It ranges from 2 to 4 meters (6–13 feet) in length. The head is rounded, pin-head in size, and is succeeded by a thread-like neck and by gradually shortening and widening segments. Four suckers and a projecting circle of twenty-six long and short hooklets arm the head of the tenia. The mature ones become detached, and are passed with the feces. They are about 1 cm. ($\frac{2}{3}$ inch) in length and from 6 to 8 mm. ($\frac{1}{4}$ – $\frac{1}{3}$ inch) in breadth, and about 1 meter (39.36 inches) from the head they are “approximately quadrilateral” in shape. These proglottides are bisexual. The female matrix occupies the middle of each proglottis, and is provided with from eight to fourteen irregular, tree-like branches on each side. The male generative organs are small vesicles in the anterior portion of the segment. The sexual opening is situated on one side, near the middle. The ovarian or uterine apparatus of a mature segment contains myriads of thick-shelled eggs, each one of which has an embryo with six hooklets.

Tæniarhynchus Saginatus (*Tænia Saginata*).—The beef tapeworm is sometimes called the “unarmed tapeworm,” since the head possesses sucking disks, but no hooklets. It is more common in this country and even in some of the European countries, as England. Longer than *Tænia solium*, being 4 to 10 meters (12–30 feet) in length, its segments are also thicker and larger, measuring from 16 to 88 mm. ($\frac{2}{3}$ inch) long, and from 8 to 10 mm. ($\frac{1}{3}$ inch) broad. The head of the worm as well as the ripe ovum is also slightly larger and proportionately thicker. The ovarian branches are more numerous (eighteen to thirty in number) and divide more dichotomously than those of *Tænia solium*. Proglottides are also found in the stools, where they sometimes exhibit a crawling motion that has caused them to be mistaken for individual parasites.

Diphyllobotrium latum (*Dibothriocephalus latus*, fish tapeworm) occurs most commonly in Russia, Switzerland, Holland, and the German Baltic provinces. It is the longest cestode, measuring from 6 to 10 meters (20–30 feet). The head is club-shaped, unarmed, and has two lateral longitudinal grooves as suckers. The segments may be distinguished from those of the preceding varieties named by their marked breadth and shortness, also by the centrally situated, tortuous ovarian rosette, and the sexual orifice near the center of the abdominal surface of each proglottis. The ova are larger than those of the pork and beef tapeworms, though thinner shelled and with a sort of lid at one end. They develop only in fresh water. From them is formed an embryo with vibrating cilia and six hooklets. Pike and other fish swallow these embryos, which develop into cysticerci in the muscles, peritoneum, and solid viscera. Janicki and Rosen, however, have shown to their own satisfaction that the larvæ are eaten by the *Cyclops strenuus* and *Diaptomus gracilis*, thus forming the intermediate link, since the latter are eaten by fishes. The eating of measly fish, raw or partially cooked, thus favors the development of this tapeworm in the human intestine. W. S. Nickerson,¹ Riley, and others have reported a few cases of native infestation by *Diphyllobotrium latum* occurring in Minnesota.

Symptoms.—Tapeworms may develop in man at any period of life. D. J. Milton Miller met with one in a child a few months old who had been fed on expressed beef-juice. There are no absolutely diagnostic symptoms of the presence of tapeworm that can be relied upon. Indeed, the existence of a tapeworm in the bowel may not be suspected even because of the total absence of indicative, subjective sensations. On the other hand, teniæ may cause considerable local distress and impairment of the general health. Because of this fact a knowledge of the existence of tapeworm in certain neurotic subjects leads to symptoms that exist mainly in the workings of a morbid imagination.

Alimentary symptoms of tapeworm may be as follows: anorexia alternating with a voracious appetite, constipation alternating with diarrhea, colicky pains in the abdomen, indigestion, nausea, and vomiting. Certain food (herring, garlic, sour foods) increases the colic-like pains, others decrease them, as milk, eggs, and oils.

General symptoms of the teniæ may be added, as lassitude, mental uneasiness, worry and irritability, depression of spirits, some physical prostration, and even emaciation. Various *reflex symptoms*, such as pruritus of the nose and anus, vertigo, migraine, tinnitus aurium, palpitation, visual disturbances (even temporary amaurosis), unequally dilated pupils, chorea, and epileptiform convulsions have been attributed to these parasites. But adequate cases for some of these symptoms may be found in other associated morbid conditions. The *dibothriocephalus*, however, may cause anemia, often very grave, even fatal. The blood-picture, in fact, is identical with that of pernicious anemia, as Schaumann's study of 38 cases has shown, and as was the case in three Finnish sailors seen by W. E. Robertson. This is due to a hemolytic substance elaborated by the worm. The blood-findings are otherwise unique among the verminous parasitic diseases, eosinophilia being absent. Leporsky found severe polyneuritis present in 14 per cent. of cases.

Diagnosis.—This is always to be made by the discovery of tenia segments or ova in the underclothing or stools. The doubtful presence of suspected tapeworm may be cleared by the administration of a suitable purgative, which will usually suffice to bring away portions of the worm in the dejections. I

¹ W. S. Nickerson, *Jour. Amer. Med. Assoc.*, February 14, 1920, p. 457.

would here add a special warning lest mucous casts or shreds or vegetable structures (as of onion) be mistaken for tapeworm.

The diagnosis of the variety of the tapeworm is made by a careful scrutiny of the segments.

Hypochondriasis can be excluded by repeated examinations of the stools, especially after the exhibition of cathartics, and by the uniform failure to detect portions of tapeworm or tenia eggs.

Prognosis is favorable. Indeed, *Tænia saginata* may exist at all ages and for years without any danger to the patient. *Tænia solium*, however, is attended with danger on account of the possibility of its causing cysticercosis.

Treatment.—*Prophylaxis.*—The way to avoid acquiring a tapeworm is to use none but well-cooked meats; this applies to beef and pork in particular. The use of pure drinking-water is of no little importance also. The proglottides of the tenia should always be burned, and not thrown where they may be taken into the bodies of other animals, as the cow or hog, and then be allowed to propagate. Governmental inspection of the meat-supply in abattoirs should be rigidly enforced. Ransom has shown that if carcasses harboring the *Cysticercus bovis* are exposed for six days to a temperature not exceeding 15° F. (—9.44° C.), the vitality of the cysticerci would be destroyed.

Curative.—Before administering the chosen anthelmintic the patient needs to undergo a “preparatory treatment” in order to secure the effects of the vermifuge which may be lost if the worm is embedded in mucus or if the drug is mixed with a large amount of intestinal contents. This is specially necessary in the case of *Tænia solium*, in which the cephalic hooklets are obstinately and firmly fixed to the membrane. For about two days prior to giving the remedy the patient should be restricted in diet to milk, bread and butter, and carbohydrates, without any food at all for the last twelve hours. Meanwhile the bowels should be purged gently once or twice.

In the evening preceding the day on which the drug is to be exhibited, a saline cathartic should be given to empty the bowel as completely as possible. The following morning no breakfast should be allowed, and before noon the selected anthelmintic should be administered. If the worm does not come away in a few hours, and an intense sense of pressure is felt in the abdomen, a brisk purge is indicated. The worm should be passed into a bowl containing warm water.

There are several very efficacious anthelmintic drugs to choose from. Prominent among them is male fern. Given to an adult in doses of $\frac{1}{2}$ to 1 dram (2.0–4.0) of the ethereal extract, and followed in several hours by a calomel and a saline purge, it usually succeeds in bringing away the tenia. The following formula may be given in the morning, fifteen minutes after a breakfast of coffee with zwieback:

R. Oleoresinæ aspidii, 3ss-j (2.0-4.0);
Sacchari,
Acaciæ, āā, q. s.
Ft. Emulsio,
Aquæ menthæ pip., q. s. ad f3ij (60.0).—M.
Sig. Take at one dose as directed.

If evacuation of the bowels be delayed, an enema of warm water is indicated. Another valuable remedy is pelletierin, the active principle of pomegranate; the tannate may be prescribed, dose 1 to 1.5 gm., in capsules; or, a decoction of the pomegranate bark may be used, in combination with male fern, as in the Leipsic formula (Strümpell):

NEMATODES

Helminthologists include in this class the cylindric worms, certain varieties of which are among the most common entozoa that infest the human body and inhabit the intestines.

ASCARIASIS

Ascaris Lumbricoides (*Round-worm*).—**Natural History**.—This species resembles the common earthworm, and is the most frequent in occurrence of all parasites. It usually appears in children between the ages of three and ten years. The round-worm inhabits the upper portion of the small intestine, and occurs singly or in numbers. Its body is round, fusiform, and marked with fine transverse striæ. It has a yellowish or reddish-brown color, and measures in the female from 7 to 14 inches (17.5–35 cm.) in length, and from 4 to 8 inches (about 20 cm.) in the male, its thickness being about that of an ordinary goose-quill. The cephalic extremity of the worm has three oval papillæ, furnished with fine teeth; the caudal extremity is straight in the female and curved in the male.

Lumbricoid worms develop from ova, which are about 0.05 to 0.06 mm. long, elliptic, dark reddish in color, and have a thick, resisting envelope; they occur in the feces. The eggs obtain entrance into the human intestine most probably through drinking-water and food.

The round-worm sometimes, though rarely, migrates from the small intestine. It has been vomited, and it has also crawled into the pharynx, mouth, and nares, and has been withdrawn thence by the patient's fingers. It has even passed into the larynx and trachea, causing fatal asphyxia or pulmonary gangrene. The Eustachian tube and biliary ducts may be invaded with such serious symptoms as perforation of the membrum tympani and hepatic abscess.

Symptoms may be absent, and yet the worms be found repeatedly in the stools. Existing symptoms are indefinite, and point simply to an irritative condition of the bowels. Some writers ascribe them to toxins elaborated by the worms. Serious symptoms may, however, result from the emigration of the worm, as into the biliary passages, eustachian tube, or larynx. Fever is not a necessary concomitant. Lumbricoid worms may give rise to any or all of the following symptoms: colicky pains, nausea, vomiting, indigestion, diarrhea (sometimes), restlessness, irritability, anorexia, itching of and picking at the nose, disturbed sleep with grinding of the teeth, salivation, and nervous twitchings. Very nervous children may manifest epileptiform convulsions, choreic movements, dilated pupils, vertigo, cephalalgia, mental disturbances, and even contractures.

Complications.—The development of jaundice will indicate obstruction of the bile-duct in cases in which the worms have been found in the feces. Intestinal obstruction from coiled worms has occurred. So also, suffocative symptoms coming on, especially at night, in a child with worms, may be due to a migrating lumbricoid. Perineal abscesses and inflamed herniæ that have perforated externally sometimes discharge the ascaris. H. Plew reports a case of jejunal perforation followed by suppurative peritonitis. The pleura has been opened and a macerated ascaris found in the pus of pyopneumothorax. The larvæ may invade the lungs, causing serious or even fatal pneumonia.

Diagnosis.—This is positively determined only by discovering the worms or ova in the stools.

The **prognosis** is good unless serious complications arise (*vide supra*). Crowell¹ states that cases of disease of the intestine or other parts may

¹ *Amer. Jour. Med. Sci.*, March, 1920, 380.

assume much more than their usual seriousness on account of the presence of these worms.

Treatment.—*Prophylaxis.*—The water used for drinking purposes should be obtained from the purest sources. Before giving an anthelmintic it should be borne in mind that no good result can be certainly obtained unless the gastro-intestinal tract be nearly deprived of food for from twelve to thirty-six hours, so that the toxic action of the drug used may be exerted directly upon the unprotected worm.

Santonin is the most efficient remedy. It may be given in doses of gr. $\frac{1}{4}$ to 1 (0.016–0.065) of the crystals to a child, or from gr. ij to iv (0.13–0.25) to an adult, in the form of a troche, before breakfast. A little milk or other light nourishment may be allowed, the troches being continued once or twice daily for two or three days. This treatment is to be followed by a brisk purge, preferably gr. j to iij (0.065–0.2) of calomel. I have sometimes combined small doses of calomel with the santonin in a troche, and with good effect. Xanthopsia, or yellow vision, spasms, and even convulsions, and saffron-colored urine may follow the use of santonin in cases of idiosyncrasy or overdose of the drug. Oil of wormseed (*chenopodium*) in doses of 5 to 10 drops, in emulsion, capsules, or on sugar, is useful. It is given every two hours until three doses have been taken. Two hours later a dose of castor oil is given to which is added 30 drops of chloroform.

Oxyuris Vermicularis (*Seat-, Pin-, Thread-, or Maw-worm*).—**Natural History.**—The *Ascaris vermicularis*, as this worm is also called, inhabits the colon and especially the rectum. It is a small worm, as several of the commonly used terms signify, and frequently it occurs in great numbers, sometimes agglutinated with mucus into feculent balls. It is most common in children, though found not rarely at any period of life. The female oxyuris is whitish in color and about 10 or 12 mm. ($\frac{1}{2}$ inch) long, the male being about 3 or 4 mm. (about $\frac{1}{8}$ inch) in length. Oxyures develop from ova in about two weeks after the ingestion of the latter. The eggs are irregularly ovoid, about $\frac{1}{16}$ inch (0.05 mm.) in length, and tenacious of life. By the time the embryos have reached the cecum they are sexually mature, and when the female arrives in the rectum immense numbers of eggs are deposited that mature into great numbers of worms, the latter being discharged with the feces. Sometimes the worms crawl out of the anus.

Infection with the ova may take place through water and food (green, uncooked vegetables and fruit) that have come in contact with the hands of infected persons. Scratching the anus will permit of the reception of oxyuris eggs under the finger-nails (Zenker and Heller), and in careless, ignorant, and uncleanly persons the possibility of such an auto- or re-infection should be recognized and avoided.

Symptoms.—*Pruritus ani* (itching of the anus), sometimes burning pain, and tenesmus, with restlessness and disturbed sleep are the commonest symptoms of the presence of this parasite. The itching is always worse at night, and may be paroxysmal. An herpetic or eczematous eruption around the anus should arouse suspicion, particularly in children, of the presence of the oxyuris in the rectum, and it accounts for the intense itching. Anorexia and anemia, rectal irritability, and “nervousness” may be associated. It is believed that the migration of the worms into the vagina may excite vulvovaginitis, pruritus, and leukorrhea, and that habits of masturbation may be induced in both girls and boys by the sexual irritation caused by the worm. Inspection of the stools will reveal, in positive cases, the whitish, thread-like parasites.

Diagnosis.—The pruritus, indicating rectal trouble, will direct the physician's attention to the anus, where the oxyures may be seen; if not found, their

discovery in the feces or the discovery of the eggs by microscopic examination will suffice.

The **prognosis** is good, and proper treatment is always effective, though occasionally exceedingly refractory cases are encountered.

Treatment.—The exhibition of anthelmintics and purgatives, such as recommended for destroying and removing the lumbricoid worm, may be effective against seat-worms also in reaching those lodged in the bowel above the rectum. C. W. Stiles states that the adult worm lives in the small intestine and should be driven into the large intestine by an anthelmintic before local injections are given. Ashford recommends beta-naphthol in 2 dram doses. The larval forms may be killed by methylene-blue in pills—18 to 24 1-grain pills daily for five days. This treatment is to be taken three times, ten days apart. Attacking the oxyures directly, however, by means of enemata is rational treatment.

The rectum should be well emptied of feces, so that the worms may be exposed to the action of the medicament injected, and for this purpose enemata of cold water, either simple or with salt or soap, may be resorted to. Injections containing the decoction of quassia (1 or 2 ounces—30.0–60.0—of the powder or chips to the pint— $\frac{1}{2}$ liter—of water) are nearly always curative. Other useful remedies are carbolic acid, turpentine, tannin, vinegar, camphor, potassium sulphid, and the oil of eucalyptus. The injections should be repeated once or twice daily for at least ten days.

Rectal irritation may be allayed by injections of laudanum and starch-water (gtt. iij–v to the ounce—30.0). Anal itching is often amenable to carbolized vaselin at bed-time, or to belladonna ointment.

Ascaris Alata.—This is another name for the *Ascaris mystax*, a species of worm found in the intestines of the dog and cat, and occasionally in man. It is a slender worm, with a closely rolled spiral tail and a wing-like projection on either side of the head. The female is about 6 to 7 cm. (2.7 inches), the male about 4 cm. (1.75 inches) in length. Scarcely ten instances, however, have been recorded in which this parasite has occurred in man.

Trichuris Trichiura (*Trichocephalus Dispar*).—**Natural History.**—This so-called whip-worm measures about 4 or 5 cm. (2 inches) in length, and is characterized by the very slender, hair-like appearance of the anterior two-thirds of its body, in contrast to the thick posterior portion, which is more or less straight and blunt pointed in the female, but rolled into a spiral in the male. Its particular habitat seems to be the cecum, though sometimes it is also found in the colon. It may exist in great numbers. Europeans appear to be infected with the parasite more commonly than Americans.

Propagation is effected by the microscopic eggs, which are ovoid, hard, nodular, brownish, and about 0.05 mm. ($\frac{1}{200}$ inch) in length.

Symptoms.—It is not certain that the parasite causes any symptoms.

The **diagnosis** is made by detecting the microscopic ova in the feces.

The **prognosis** and **treatment** are not called for.

UNCINARIASIS

(*Ankylostomiasis*; *Hookworm Disease*)

Ankylostoma Duodenale; Necator Americanus.—**Natural History.**—This parasite belongs to the family of *strongyloidea* of the nematoid worms. It was discovered in Milan, in 1838, by Dubini. *Ankylostoma* is found chiefly in Europe; *Necator*, in America. The former differs chiefly from

the latter in having a much stronger mouth armature. The length of the female is from 8 to 18 mm. ($\frac{1}{2}$ – $1\frac{1}{8}$ inch), and of the male from 6 to 10 mm. ($\frac{1}{4}$ – $\frac{3}{8}$ inch). Its body is thread-like, with a conical-shaped head, and a large, bell-shaped mouth surrounded by a horny capsule, and possessing four hook-like teeth, ventrally situated, and two smaller, vertical teeth on the dorsal side, by which the worm fixes itself to the mucous membrane. A bulbous-like swelling exists at the tail end of the male worm. It inhabits the jejunum and duodenum. The eggs are found in muddy water or in warm moist earth, and there liberate the embryos. These develop into larvæ, which soon enter the dormant state, remaining quiescent for an indefinite period until they are taken into the human stomach through drinking-water, food, dirt ("dirt-eaters"), or, more commonly, dirt that has collected upon the hands and about the nails. Probably direct infection through the skin, as first shown by Loos, is the usual mode of infection however, and Allen L. Smith and others have regarded the subtropical dermatitis known as "ground itch" as an expression of this mode of infection. Loos has shown that on the completion of the exogenous phase of the embryo the parasite enters through the skin, generally of the feet and legs, by contact with soil contaminated with the ova of the ankylostoma. Carried by the blood-stream to the lungs it passes into the air vesicles, then into a bronchus, to the trachea, esophagus, and stomach, and finally to the small intestine. Here sexual characters develop in the parasites, reproduction ensues, and the ova are deposited in the bowel. They do not multiply within the intestine.

Predisposing Causes.—(a) *Geographic Distribution.*—The parasite is found in Italy, Egypt, India, Philippines, Germany, Belgium, Switzerland, and in England was found by Haldane in miners in Cornwall. This parasite is the cause of "Egyptian chlorosis," first described by Griesinger. Ankylostomiasis is not uncommon in tropical countries. In Italy it has been termed *tunnel* or *mountain anemia*; in Belgium it is known as *brickmakers' anemia*; again, it occurs among workers in coal mines—*miners' cachexia*. B. K. Ashford (United States Army) has shown that a large percentage of all cases of anemia occurring in Porto Rico are induced by this parasite. H. F. Harris has found the ankylostoma prevalent along the Gulf of Mexico and in the southeastern section of the United States. The Rockefeller Sanitary Commission, after a survey made to determine the degree and extent of hookworm infection, showed that hookworm disease belts the earth in a zone about 66 degrees wide, extending from parallel 36 north to parallel 30 south latitude. Not less than 58 per cent. of the earth's estimated population is in the infected area. The importation of infected Italian, Hungarian, and Polish laborers may be accountable for the propagation of the parasite in the United States. (b) *Sex.*—Males and females are infected to the same extent. (c) *Age.*—The greatest infection occurs between the age of six and sixteen years (Wells). (d) *Uncinaria in the Army.*—Studies made in the U. S. Army during the Mexican Border mobilization showed that Southern regiments were frequently severely infected with the parasite. In some cases as many as 80 to 90 per cent. of the regimental personnel would be affected. Systematic examinations were made of the stools of the troops collected in the cantonments before sending them to Europe. Here also a large number of infected soldiers were discovered. For example, Traube, Kielty, and Havercampe¹ in 6159 examinations of feces found 1504 were positive.

Pathology.—The ankylostoma is probably nourished by the plasma of the blood it sucks from the intestinal vessels. It is found *postmortem* sometimes in the mucous coat, rolled up in a little blood cavity. Ecchymoses, containing a central opening through which blood can ooze, are the usual result

¹ *Military Surg.*, 1918, lxii, 287.

of the worm's action. Chronic catarrhal enteritis is usually associated. Hypertrophic dilatation of the heart is observed.

Symptoms.—The chief symptom is progressive anemia (secondary), and the skin is a pasty yellow or dirty gray color, called in the southern part of the United States "Florida complexion." When the number of ankylostoma embryos introduced into the intestine is large, the anemia may develop acutely; when but a few are introduced, the withdrawal of blood is more gradual, and *chronic anemia* develops. The most recent view to explain the anemia, however, is that "a hypothetical toxin is produced by some extraneous organisms, such as intestinal bacteria, the products from which find their way through the damaged mucosa."¹ The impoverishment of the blood has been so profound as to simulate a pernicious anemia.

Ashford found the red cells to vary between 700,000 and 3,525,000 per cubic millimeter, and the hemoglobin between 10 and 55 per cent. *Leukocytosis* is not a feature of uncomplicated cases; the polymorphonuclear cells may show slight reduction, and the lymphocytes a moderate increase. Eosinophilia is common in this as in many parasitic diseases, and may reach 40 per cent. or more. In mild cases, however, eosinophilia may not be available for diagnosis, in which case the feces should be examined for eggs. The red cells are pale, of irregular size and outline; normoblasts are plentiful, and less often megaloblasts are found.

There may be, in addition, slight gastro-intestinal disorder (anorexia, colicky pains, nausea and vomiting, and constipation alternating with diarrhea). A trace of blood is constantly present in the feces, and Whyte² suggests a phenolphthalein test, which reveals its presence in a dilution of 1:800,000. In cases marked by an acute development of anemia considerable general weakness, dyspnea, and dropsy may ensue. There is no loss in weight; but swelling of the feet and ankles, sleeplessness, headache, faintness, palpitation, and scanty perspiration are common symptoms. The renal function is maintained and slight fever may develop. Corneal ulcer is not uncommon. Lemann³ describes infantilism in uncinariasis. Many cases have but few subjective symptoms, but even in these there is a marked diminution of resistance to infectious and contagious diseases.

Physical Signs.—Only those severely affected show much change from the normal, but in these individuals the area of cardiac dulness is increased. Various murmurs—hemic—may be heard, and palpitation and dyspnea are common. In those affected the face is peculiarly dull, expressionless, and, owing to the marked metabolic disturbance, the growth of young subjects is greatly hindered.

Diagnosis.—This is made by finding the eggs or mature worms in the feces. The former are oval shaped, about 0.05 mm. ($\frac{1}{200}$ inch) in length, and have a much thinner shell than the ova of the round worm. Ova are seen with a $\frac{1}{2}$ objective and are commonly entangled in the mucus that escapes with the feces. Suspicious specimens, if negative, should be centrifuged, Bass's⁴ method being preferable for the purpose. "If in doubt as to the diagnosis of the eggs, they may be hatched out in twenty-four to forty-eight hours and the characteristic larvæ looked for" (Dock and Bass). In cases of pronounced anemia, in which the cause is obscure, the patient's dejections should be carefully examined.

Duration.—The disease may last for months or for several years.

¹ Editorial, *Jour. Amer. Med. Assoc.*, May 16, 1914, p. 1561.

² *Annals of Tropical Medicine and Parasitology*, Liverpool, April, 1916.

³ *Arch. Inter. Med.*, Chicago, August, 1910.

⁴ "Hookworm Disease," Dock and Bass, pp. 175, 176.

man the larvae are liberated during the digestive process. Passing into the intestines, they reach the adult stage in from two to four days, being then sexually mature, and in five to seven days more they produce hundreds of living embryos.

The intestinal trichinae become fully grown, and then usually die in from four to five weeks. The female trichina may bring forth several broods of embryos during her life-period in the intestine. The living embryos leave the intestine at once, and invade the muscles through various channels—principally along the connective-tissue routes—so that the symptoms of muscular irritation develop from seven to ten days after eating the trichinous meat. The embryos attain maturity (larval form) in about two weeks after entering the muscular tissues. Their presence causes a mechanical irritation that results in the formation of a fibrous capsule in from four to six weeks. In man it probably becomes encysted at a later period than in the lower animals, as shown by the accompanying illustration, taken from a case under the immediate observation of Dr. L. Napoleon Boston (Fig. 27). Usually but a single worm is found within one capsule, though occasionally three or four are seen. The encapsulated trichinae may live many years in the muscles. With increasing age the capsules become thicker and may be the seat finally of calcareous infiltration. In the hog, calcareous infiltration of the capsule is the exception, hence the difficulty, even impossibility, of seeing them with the unaided eye.

Pathology.—The diaphragm is most thickly infested with the larval trichinae. Next in order are such trunk muscles as the intercostals and abdominals, then the muscles of the neck, including the larynx, head, eyes, and extremities. Up to the seventh week of the disease the intestinal trichinae may be very numerous. *Microscopically*, the muscles show "the changes characteristic of acute myositis" (Fitz) after the fifth week. The trichinous cysts in the muscles may be seen with the naked eye as small, grayish-white, opaque, "oat-shaped" specks, longitudinally disposed in the meat-fibers.

Sources of the Trichina.—The trichina was first found in pork—the usual source of trichiniasis in man—by the late Joseph Leidy. Recent investigations show that the live trichinae may be found in the fatty as well as the fleshy portion of pork. The pig is infested by eating trichinous rats, trichinous pork, or human or porcine excrement containing the embryos of propagating intestinal trichinae. The rat may be the original host of the parasites, or it may itself become infected by older rodents eating their fellows, or by eating trichinous pork or human or porcine excrement.

As to the frequency of the infection of hogs, it may be said that about 2 per cent. were found to be trichinous, according to Salmon's report (1884), of nearly 300,000 examinations of American pork. In

Prussia, according to Eulenberg's statistics, the ratio is decidedly less varying—from 1 to 2160 hogs (1876) to 1 to 1817 (1889). "The dissecting room and *postmortem* statistics show that from $\frac{1}{2}$ to 2 per cent. of all bodies contain trichinae" (Osler).

Fig. 27.—Trichina spiralis from the head of the right gastrocnemius muscle three weeks after the first symptoms appeared (Queen obj. $\frac{1}{2}$, eye-piece No. 11).

Of course man, as a rule, becomes infected by eating raw or partially cooked pork containing living muscle trichinæ (larvæ). Eating raw ham and sausages, a habit common among the Germans of Prussia (particularly during picnics), and in some parts of the United States where German emigrants have settled in large numbers, explains the comparative frequency of this disease in such localities. About 900 cases have been reported in the United States in the past forty-five years (Beecher). Trichiniasis has occurred in epidemic form in North Germany, France, Spain, Russia, the Scandinavian countries, and in several of the northwestern United States.

Symptoms.—*Postmortem* examination often reveals the presence of unsuspected muscle trichinæ.

In well-marked cases of infection *gastro-intestinal disturbances* appear on the second or third day after the ingestion of the affected meat. Vomiting, diarrhea, and colicky pains in the abdomen may be present. The diarrhea sometimes takes on the characteristics of a choleraic attack or may be followed by obstinate constipation.

Extreme "muscular weariness" and bodily fatigue often occur for several days before the embryonic parasites can have begun to wander into the muscles. On about the fifth to the tenth day, when migration usually commences, *chills*, followed by a temperature of 101.5° to 104° (38.6°–40° C.), and marked *myositis* come on. The muscles are stiff, tense, painful on pressure and motion, and somewhat swollen. The flexors of the extremities are particularly sore and often firmly contracted, causing the knees and elbows to be acutely bent. *Mastication*, *deglutition*, and *phonation* may be difficult and painful because of the involvement of the muscles of the jaws, pharynx, larynx, and tongue. Intense *dyspnea* is frequent on account of the involvement of the diaphragm and intestinal muscles. The *temperature* shows marked remissions in most cases, and is an almost constant feature. The *pulse* varies with the temperature.

Edema is characteristic in nearly all of the cases. It appears on about the seventh day after the infection, and begins in the face (frontal region), usually being noted first in the eyelids, and extending thence to the extremities and trunk during the height of the muscular symptoms. It may last for several days, then disappear for several days or a week, and reappear. Ascites even has been observed. Edema of the larynx and bronchial catarrh, the latter rarely leading to bronchopneumonia, may also supervene and add to the gravity of the dyspnea. Minot and Rackemann reviewed 102 cases and found in 35, or 34.5 per cent., abnormal physical signs in the lungs. Profuse sweating may last for several weeks. Miliaria, urticaria, acne, furunculosis, herpes, and pruritus may occur as skin manifestations. Insomnia, headache, a temporary loss of the tendon reflexes, and dilatation of the pupils (Rupprecht) have been noted among the nervous symptoms. Salzer found the Kernig reaction present in all of a group of 14 cases. Prolonged cases show a marked degree of emaciation and anemia. T. R. Brown found a decided increase of the eosinophils in the blood, amounting to 37 per cent. This eosinophilia arises during the migration of the embryos, from five to seven days after infection, and may either disappear soon or persist years after the symptoms have subsided. Severe infections may show a low eosinophil count during the acute stage. Opie administered *Trichina spiralis* to the guinea-pig, and found that a resulting mild infection stimulates the eosinophil cells to active multiplication, but severe infection causes their destruction. A marked, absolute leukocytosis is the rule.

There is little doubt that the "muscle symptoms," varying with the muscle attacked, can be explained on the basis of a reactionary inflammation (*myositis*). Flury has shown that poisonous products arise from the trichinæ,

on the one hand, and that chemical products result from degradation of the invaded and damaged muscle tissue on the other.

Complications, as a typhoid state, hypostatic pneumonia, and pleurisy, may appear. Albumin, with casts, are found in the urine.

Recovery is effected in mild cases within two weeks, while in the severe ones from six weeks to several months may be occupied.

Diagnosis.—The following symptoms are regarded as pathognomonic: sudden swelling of the face, coming on after the patient has suffered for several days from muscular soreness; loss of appetite, fever, and profuse sweats (Böhler); painful, tender, and “rubber-like” hardness of the muscles, with difficulty in movement; semiflexed extremities; gastro-intestinal catarrh, with a red, dry, coated tongue; dyspnea, diarrhea, and edema of the extremities following the subsidence of that first noticed in the face. Friedreich emphasizes hoarseness, and the late Dr. Packard rapidity of respiration without evident cause. Cott and Lintz first found trichinella embryos in the cerebrospinal fluid, and they have also been isolated from the blood. Blood-cultures and lumbar puncture with examination for embryos should therefore be carried out as routine procedures.

Differential Diagnosis.—*Meat- and sausage-poisoning* may be distinguished from trichiniasis by the more rapid course of the former, the dry throat and skin, jaundice, visual disturbances, and the absence of edema and muscular symptoms.

Direct examination of the passages and of the muscles may be resorted to. The discovery of the parasites in the pork a portion of which has been eaten by the sick establishes the diagnosis. A low-power microscope should be used to examine the intestinal mucus for the trichinæ. Light purgation should precede this endeavor. Harpooning such muscles as the biceps for the purpose of removing some muscle-fiber, or directly incising a small portion under Schleich’s method of infiltration-anesthesia, may permit of a positive diagnosis.

Acute rheumatism, cholera, typhoid fever, and acute polymyositis (pseudo-trichiniasis) may at times resemble trichiniasis. Epidemics of the parasitic disease are more readily diagnosed than an isolated case.

Prognosis.—This depends upon the number of parasites ingested and upon the number of embryos generated in the intestines. Marked early diarrhea is favorable. The prognosis should be guarded, as death may occur as late as from the fourth to the sixth week. Of 357 cases collected by Packard, the mortality was 24.07 per cent.

Treatment.—Prophylaxis is of supreme importance, both as to the infection of the hog and the danger of eating infected pork. Care should be exercised in the feeding of swine, and the destruction of rats should be made as complete as possible in and about the styes. Pig excrement should be removed and burned, and feeding with milk, bran, grain, and vegetables should be forced upon all keepers of swine.

Rigid inspection of the meat supply, as is done in Germany, should be carried out by government sanitary officers. Decidedly the safest and most efficient way to prevent trichinosis is to thoroughly salt, smoke, and cook the pork that is to be used. Winn’s experiments suggest that refrigeration (cold of about 17.8° F.—8° C. for a number of days) effectually destroys the life of the encysted larvæ. Putrefaction does not kill the parasites.

The treatment of those who have eaten trichinous meat should be by a prompt evacuation of the bowel, especially within the first twenty-four hours, as after the embryo young have been brought forth and have passed into the muscles no known treatment is successful in attacking them. Calomel is

and only in the lymphatics, are called *Filaria bancrofti*; the embryos, which alone are found in the circulating blood, are termed *Filaria nocturna*. The first is a white, opaline thread-like worm, tapering toward the ends, which latter, however, are blunt. The male is 83 mm. (3.2 inches), the female 155 mm. (6.1 inches) long. The second worm is known only in embryonic form, and is distinguished by granulations in the axis of the body. This is the *Filaria diurna*, of which the adult form is said to be the *Filaria loa*, now known to be the cause of Calabar swellings. Manson found them in the blood of Congo negroes, but only during the daytime. On the other hand, the nocturnal filaria is found only at night, or, if the host be either by habit, necessity, or choice a day sleeper, during this time, showing, then, that there is some condition of the body during quietude that is conducive to the appearance of the filaria in the blood (Granville). Manson observed that during the diurnal temporary absence of the filariæ from the cutaneous circulation they are found principally in the larger arteries and the lungs. This "filarial periodicity" is a striking characteristic. Inversion cannot be induced in cases of *Filaria diurna*. Rivas and Smith, however, hold that the periodicity of filarial embryos in the peripheral blood is related to the relative number of them circulating in the blood, and that an absolute absence does not occur at any hour of the day or night.

Filaria philippinensis is also worthy of mention. Ashburn and Craig conclude: (a) That the complete development of *Filaria philippinensis*, discovered by them in 1906, has been followed in the mosquito, *Culex fatigans*; (b) that the *Filaria philippinensis* is distinguishable from other filaria "both in the blood and during the developmental cycle within the mosquito"; (c) that as regards the time of its occurrence in the blood the organism presents no periodicity.

The embryos of *Filaria sanguinis hominis* are produced by the female in great numbers, and are so small that they readily pass through the capillaries. According to Manson, who in 1877 found the larvæ in the stomach of a female mosquito, it is probable that after filling itself with the blood of an infested man during sleep, the mosquito seeks stagnant water, dies, and the larvæ are set free. In this way it may happen that man takes in the embryos through the drinking-water. More recently it has been shown that the filaria, once in the stomach of the mosquito, sheds its delicate envelope, then pierces the wall of the mosquito's stomach, and lodges in the thoracic muscles. Here it undergoes further developmental changes during two weeks, then finds its way into the proboscis, to be discharged into the blood of the human host. They find a permanent seat in the lymphatics of the human host, mature, and bring forth young, which may again infest the blood by passing through the lymph-ducts into the thoracic duct and general circulation.

The geographic distribution of filariasis is limited mainly to the tropics and subtropics. It is most common in Brazil, the West Indies, Mexico, the Southern States, Southern China, India, Egypt, a part of Australia, and the southern Pacific islands, where it is endemic.

The symptoms of filariasis are in abeyance until some obstruction and inflammation of the lymph-channels is caused by the parasite. There are several conditions or endemic diseases produced. **Elephantiasis arabum** is believed by Manson to be the effect of these parasites, in a certain proportion of cases at least. In specimens of night-blood from 88 Cochin Chinese he found larvæ in 21; 14 specimens came from patients with elephantiasis, and only 1 showed filariæ. This latter fact, he explains, is to be expected, since, in order to give rise to elephantiasis (due to an infarction of the lymphatic glands connected with the diseased areas), the adult filariæ must lie on the distal side of

st. The male worm is unknown. The worm has an inexplicable affinity for the subcutaneous and intermuscular tissues of the feet and legs, where it attains full development.

Symptoms.—Wherever the parasite is situated, it may often be felt coiled up under the skin, which at that point becomes red and fluctuating like an abscess. When opened, either surgically or naturally by the worm, the head appears through the aperture. The favorite spot for perforation is the dorsum of the foot, though sometimes it extrudes from the legs, rarely the thighs, and very rarely from the thorax and abdomen.

Treatment.—Prophylaxis in regard to the drinking-water and as to bathing where the intermediary host of the dracunculus—the cyclops—has its habitat is essential for safety.

The treatment embraces the surgical measures necessary to remove the worm and to promote the healing of the irritated tissues. Roth claims that after incision the application of carbolic acid (1 : 15) causes the worm to be removed in two or three days. Native Indian physicians commend highly the local application of the leaves of the “amarpattee” plant.

OTHER FILARIÆ

Among other filariæ that have been found in man are the following: The *Filaria immitis*, which causes hematuria and has been found in the portal vein, while the ova were discovered in the ureteral and vesical walls; *Filaria labialis*, found in a lip pustule; *Filaria lentis*, found in a cataract; *Filaria trachealis* and *bronchialis*, seen in the trachea, bronchioles, and lungs; *Filaria hominis oris*, observed by Leidy in the mouth of a child; *Filaria loa*, noticed in the tropics among negroes, its habitat being beneath the conjunctiva. Recently L. N. Boston found *Filaria mermus* (according to Wardell Stiles, to whom he referred them) in a cavity in the center of an apple. They are believed to be parasites of the apple worm, but whether pathogenic is not known.

OTHER AND UNCOMMON NEMATODES

Eustrongylus Gigas.—This parasite is exceedingly rare in man, but has been found in many of the carnivora and in some herbivora. It is supposed that fish act as the intermediary host for the larvæ. The worm is enormous in size, the female being from 25 to 100 cm. (10–40 inches) in length. It is a red, cylindric parasite with blunt-pointed ends. Its seat is the kidney, which it may destroy, causing hematuria and the presence of the eustrongylus ova. Dr. John McKenna has recovered an adult eustrongylus from a child whose urine had long contained ova.

Anguillula stercoralis or **Strongyloides intestinalis** occurs in the stools of certain tropical endemic diarrheas. It is common along the Gulf of Mexico. The parasites are oviparous, and the eggs may be taken through the drinking-water. They have been found in the biliary and pancreatic ducts, as well as in various parts of the intestines. The administration of thymol or maleim is to be recommended.

Echinorhynchus moniliformis occurs in rats, and in one case, that of ailian reported by Calandruccio, the ova were found in the feces.

above and behind the ears and in the neck is often associated. "Plica polonica" was a phrase once used to designate the matted condition of the hair in extremely dirty, crusty, and long-neglected cases of head-lice. Secondary adenopathy of the cervical lymphatic glands is a common feature in neglected cases.

Pediculus Vestimentorum (Corporis).—This louse inhabits more often the clothing than the body itself. It is larger than the head louse, and, like the latter, moves slowly. The nits are found with difficulty on the fibers of the underclothing. It sucks blood through a proboscis inserted into the sweat pores, and after withdrawing leaves a minute hemorrhagic speck. Irritation of the skin is produced, and in old cases, as in filthy tramps, the skin becomes scaly and quite pigmented (vagabonds' disease). The efforts at scratching are almost frantic, and after a cure is effected, parallel white lines, the remains of scratch-marks, followed by atrophic changes, may be visible, as in a case that I reported.

Pediculus or Phthiriasis Pubis (Crab-louse).—This parasite is not limited to the pubis, but attacks also the hairy region in the axilla, on the chest, and may even reach the beard and eyebrows. It clings firmly to one or two hairs close to the skin. Its six legs with strong claws are placed closely together at the anterior part of the ovoid body. Lice have been shown to transmit typhus fever, as well as impetigo and favus.

Treatment.—The hair should be cut short where the head-lice and nits are abundant. Saturating the hair and scalp with kerosene oil for twenty-four hours usually kills the parasites. *Body lice* may be destroyed by scalding the underclothing and hot-ironing carefully about the seams. A hot soap-and-water bath is sufficient for the body, and sedative and antiseptic ointments may be useful adjuvants. Mercurial and beta-naphthol unguents usually suffice in treating for *Pediculus pubis*. Prof. J. V. Shoemaker affirms that naphthol is a remedy that meets the indications presented by all forms of the disease; he prepares it as follows:

R. Beta-naphthol, 3j (4.0);
Cologne water, f3iv-vj (120.0–180.0).—M.

Cimex Lectularius or Bedbug.—This too well-known parasite is flat, brownish-red in color, and from 2 to 5 mm. ($\frac{1}{12}$ – $\frac{1}{8}$ inch) in length. It infests beds and public vehicles, emitting a disagreeable odor. It is a blood-sucker, and causes considerable itching, local irritation, and urticaria even in some persons, while others are unmindful of their attacks. The bedbug may transmit kala-azar, relapsing fever, or trypanosomiasis. Sulphur fumigation and mercuric chlorid applications to the harboring places of the bedbugs are effectual destructive agents. Saturated sodium bicarbonate solution will relieve the burning and itching.

Pulex Irritans (Common Flea).—This "ubiquitous" parasite is from 2 to 4 mm. ($\frac{1}{12}$ – $\frac{1}{8}$ inch) in length, black or (when filled with blood) brownish-red in color, having six legs, the hind ones of which are relatively very large and powerful, enabling it to jump many times its own height. A flea's bite causes a sharp sting, and leaves a slightly raised red spot with a dark, pin-point center, the site of penetration of the biting apparatus of the insect. The importance in medicine of fleas is that they may transmit plague, leishmaniasis, or tape-worms and other intestinal parasites. Treatment is the same as for the preceding insect.

Pulex Penetrans (Jigger).—This parasite, also called "sand-flea," is indigenous to the West Indies, South America, and the Southern States. The impregnated female penetrates the skin, especially that of the feet, for pur-

SYPHILIS

Definition.—A chronic infectious disease communicable from person to person by direct or indirect contact with a specific virus, or by heredity. According to its clinical course, it is characterized by five periods: (1) Period of primary incubation—the time which elapses between contact with the poison and the appearance of the chancre. (2) Period of secondary incubation—the time which elapses between the appearance of the initial lesion of the disease (the chancre) and the development of its cutaneous manifestations. (3) Period of secondary symptoms (skin eruptions). (4) Intermediary period characterized by the absence of lesions, although evidence of existing dyscrasia can still be found. (5) Period of tertiary symptoms. The hereditary form of the disease is transmitted at the time of procreation by the sperm virile, by the ovum, or by both. Prince Morrow points out that the important lesions of the disease are those that occur in the internal organs—*visceral syphilis*.

General Pathology.—(a) **Primary Lesion of Chancre.**—This appears at the site of inoculation, and is characterized by infiltration of the connective tissue chiefly with round cells of the same type as those seen in recent granulations. There is sclerosis of the small blood-vessels, chiefly involving the adventitia of the arterioles, the result being the formation of an ulcer with a characteristic indurated edge. The neighboring lymphatic glands soon undergo hyperplasia and induration.

(b) **Secondary Lesions.**—Macular and maculopapular eruptions are frequent, and, with the mucous patch, show round-cell infiltration of the connective tissue and blood-vessels similar to that found in the chancre, with plasma cells and leukocytes. The favorite sites for mucous patches are the mucocutaneous junctions (mouth, anus, etc.). Other lesions of this stage are general adenopathy, alopecia, and pharyngitis.

(c) **Tertiary Lesions.**—These are circumscribed inflammatory products known as gummata. They appear in the connective tissue, bones, periosteum ("nodes"), skin, muscles, brain, liver, lungs, kidneys, heart, testes, etc. The gummata, though usually sharply circumscribed, may take the form of diffuse infiltrations and vary in size from a pin's point to a hen's egg. At first firm and hard, they early show signs of fluctuation and rapidly break down into extensive ulcers. Their color is grayish, and on section they show a caseous, semi-opaque center, with a fibrous, translucent periphery. Warthin¹ does not believe that the gumma represents the typical lesion of tertiary syphilis. He holds that it is relatively rare, whereas the essential lesion is an irritative or inflammatory process characterized by lymphocytic and plasma-cell infiltration into the stroma about the lymphatics and blood-vessels, with early tissue proliferations, succeeded finally by fibrosis and atrophy or degeneration of the parenchyma. These lesions are most readily made out in the nervous system, heart and aorta, pancreas, suprarenals, and testes.

The other characteristic finding in tertiary syphilis is a "diffuse infiltration of tissue with wandering cells and a proliferation and new formation of connective tissue; the smaller blood-vessels generally show thickening of the intima and changes in the endothelium which may result in their practical obstruction" (MacCallum).

Microscopically, the gumma consists of lymphoid cells, plasma cells, leukocytes, and epithelioid cells, in which fatty degeneration and softening result in the formation of a pasty mass. The mass thus formed may either be absorbed or persist; but in most instances coagulation necrosis occurs in the

¹ *Amer. Jour. Syphilis*, 1918, ii, 425.

center, with conversion of the peripheral zone into fibrous tissue. Gummata of certain structures (skin, mucous membrane, bones, and cartilages) often lead to destructive ulceration and sloughing.

General Etiology.—Parasitology.—Schaudinn and Hoffman in 1905 described a spiral micro-organism from the deeper layers of the chancre, condylomata, and lymph-glands, the specific organism, or the *Spirochæta pallida* (*Treponema pallidum*). The *Spirochæta pallida* in length varies from one to six times the diameter of a red blood-cell, in width from unmeasurable thinness to $\frac{1}{2} \mu$. Metchnikoff and Roux have isolated this organism in acquired syphilis of man and in experimental lues in the monkey and ape. Reasoner has been able to demonstrate, to his own satisfaction, fixed differences in the various strains of spirochetes as studied in the adult rabbit.

Predisposing Causes.—Since acquired syphilis originates only by inoculation, it is obvious that a break in the cutaneous or mucous surfaces is essential to infection, such as a slight abrasion, fissure, or laceration, etc., particularly of the genital mucosæ. Other surfaces may also be the seat of infection, as the lips, hands, etc.

Susceptibility to the virus is universal, and no age is exempt. *Re-infection* is rare, but does occur at times with great frequency.

Contagion of Syphilis.—The blood of a syphilitic during the secondary period, and the secretion from the chancre or any of the secondary lesions, are contagious, the lesion at the point of inoculation always being a chancre. The physiologic secretions, saliva, sweat, milk, and semen, do not convey the spirochetes unless contaminated with the discharges from some of the lesions of the primary or secondary stage. The spirochetes are harbored in gummas or other late syphilitic lesions and, under proper conditions, can produce the primary and secondary lesions as readily as spirochetes from primary or secondary syphilis. The semen contains spirochetes which, however, do not invade the germ cells.

Modes of Infection.—(1) In a great proportion of the cases (about 70 per cent.) syphilis is transferred by illicit sexual intercourse.

(2) *Accidental Inoculation.*—This is not uncommon. (a) Most frequently it is accomplished through the pernicious custom of indiscriminate kissing (lip chancre), and I have personal knowledge of not less than 8 instances in which infection has occurred through labial contact. In Russia from 75 to 80 per cent. are acquired in this manner from popular customs.

(b) The site of inoculation may also be the mouth and tonsils, the virus being conveyed during the low practices of sexual perverts or by kissing. The wet-nurse may infect the mouths of suckling babes, or, *vice versa*, the infant may infect the nipple of the nurse.

(c) The obstetric finger may become infected. Three instances of this sort have come under my own observation, and Fournier gives the details of 40 cases of primary syphilitic infection of the hand. In 30 of these the malady was acquired in medical practice (4 obstetricians, 20 general practitioners, students, and 3 midwives). Montgomery states that chancre of the finger is peculiarly frequent in physicians infected while treating syphilitics or at post-mortems of those dead of syphilis.

(d) Humanized vaccine virus may rarely transmit the disease.

(e) Accidental infection has at times (though very rarely) taken place in a variety of other ways—*e. g.*, handling foul rags from the hospital ward, by bed-clothing, drinking-cups, the pipe and cigar, tattooing, etc. I have personal knowledge of 2 cases of chancre of the hand where 2 boys were tattooed by a syphilitic with mucous patches in the mouth—the needles being infected by the saliva of the operator.

Krafft-Ebing found that out of 3455 cases $15\frac{6}{10}$ per cent. were of extra-genital origin. The lesion was upon the lips in 51 per cent.

(3) *Hereditary Transmission*.—The intensive study of syphilis that has taken place in the past few years, particularly by means of the Wassermann reaction, has shown conclusively that many of the former ideas about hereditary transmission of syphilis are entirely wrong. The disease is not hereditary in the sense that certain hereditary characteristics are transmitted from the chromosomes of the germ-cells; it is distinctly and clearly an intra-uterine infection. As such the spirochetes exist in the placenta and the fetal organs, carried there in the very great majority of cases by the maternal blood. Whether infection of the fetus can occur without maternal syphilis is a moot question. The majority of authorities hold that the spirochetes cannot be carried by the spermatic fluid to infect the embryo without infecting the mother (Fordyce).¹ However, apparently healthy mothers with syphilitic children have been shown to have syphilis in the great majority of cases by the positive Wassermann reaction. Thus, the so-called Colles' law, immunity of the apparently healthy mother of a syphilitic child, has been discarded as a result of the serologic tests. Likewise, Profeta's law, immunity of a healthy child of a syphilitic mother, is untrue.

Clinical History of Acquired Syphilis.—(a) **Primary Stage**.—The typical *initial lesion* (chancre) appears about three weeks after infection, and is followed soon by swelling and induration of the nearest lymphatic glands. The primary sore begins as a *red papule*, which rapidly reaches its maximum, and then undergoes a central necrosis with the formation of a *small ulcer*. The adjacent structures become hard or cartilage-like—a characteristic to which the lesion owes its name of "hard chancre." A small chancre may often escape detection, especially if it be situated inside the meatus. When situated upon a mucous membrane it is always a *chancrous erosion*, which may be so mild and of such brief existence as to come and go without the knowledge of its bearer. Particularly is this the case in the female. The *general symptoms* are negative in this stage.

(b) **Secondary Stage**.—This is announced about six weeks after the appearance of the infecting chancre by *moderate fever* (100° to 101° F.— 37.7° – 38.3° C.), exceptionally higher, accompanied by languor, headache, bone-pains, impaired digestion, and a slight degree of prostration. There is angina, with hyperemia of the fauces and hard palate. The blood shows a marked reduction in hemoglobin with some diminution in the number of red cells. *General lymphatic enlargement* is seen, especially significant in the postcervical and epitrochlear glands. Acute splenic enlargement may appear, especially if the general health has been seriously involved.

Skin eruptions are of many forms. The *erythematous* or *roseolar* is the earliest and most common, coming out abundantly upon the trunk (especially the chest), buttocks, thighs, and forehead. Another early variety is the *papular*. The papules are small or large, hard, and appear on the face, trunk, and flexor surfaces of the extremities.

Mucous patches may appear on the visible mucous surfaces (angles of mouth, tongue, tonsils, pharynx, vulva, vagina, penis, and around the anus), and are among the early and constant lesions. The distribution of these early syphilids is symmetric; their outlines are rounded; their color like that of a slice of raw ham ("coppery"); they are polymorphous; and, as a rule, they excite neither pain nor itching.

Other and later-appearing eruptions may be *pustular* and *tubercular*. These show a tendency to bunch in certain areas, and hence are less diffuse

¹ *Amer. Jour. Med. Sci.*, 1915, cxlix, 781.

than the afore-mentioned eruptions; and are not symmetrically distributed on the body.

Other frequent symptomatic conditions arise during this secondary period, such as alopecia, laryngitis, iritis, choroiditis, retinitis, and epididymitis (very rarely). The hairs of the eyelids and eyebrows may fall off and the fingernails become brittle.

The *secondary* symptoms last from two to three months (the usual duration) to a year or more, and are followed by a period of apparent good health lasting for an exceedingly variable interval (from a few months to many years) before the tertiary stage sets in. During the secondary stage the symptoms may be severe, mild, or even absent. There is a *late secondary* syphilis, the symptoms appearing a variable number of years after the primary lesion.

(c) **Tertiary Stage.**—As I have already stated, the secondary period is generally followed by a variable interval of freedom from symptoms, but to this rule there are numerous exceptions, and among not uncommon occurrences may be witnessed the appearance of tertiary symptoms during the secondary stage. As stated by R. W. Taylor, "By far the most potent and frequent cause of tertiary syphilis is the absence or insufficiency of treatment during the secondary stage." Belonging to the third stage are certain skin eruptions, especially the characteristic *rupia*, which first appears in the form of pustules that break and form ulcers that are covered with dry, laminated crusts "like an oyster shell." To this stage also belongs the *tubercular* variety, affecting the face, back, and legs, and very commonly the elbows, and rarely other portions of the bodily surface. These eruptions involve the true skin, and in healing leave scars, but, unlike the secondary cutaneous lesions, they are neither infectious nor contagious, are not, as a rule, symmetric, and are more liable to be attended by itching. A purpuric syphilid (blood extravasation form) is also met with in this stage. True *gummata* may develop in the skin and subcutaneous tissue, and these break down and form kidney-shaped ulcers which tend to spread in a serpiginous manner. On healing (a process that is accomplished with difficulty), scars result. Gummata may occur in the mucous membrane and pass through the stages of ulceration and cicatrization. When situated in the larynx or trachea, their healing is attended with narrowing of the organ, and when in the lower bowel or the rectum, dysenteric symptoms, followed by actual stenosis, may result.

In the muscles gummata occur and form small hard tumors. They may also cause periostitis and death of the bones, especially of the nose, palate, and skull; "nodes" are thus formed, which are situated chiefly upon the tibia and the skull in larger or smaller numbers, and also, though less frequently, upon other bones. These are exceedingly painful, particularly at night, and are very tender. They may be true gummata, but more often, if not absorbed, they either become ossified or undergo fibroid change, while in rarer cases they suppurate. Chronic enlargement of the lymphatics and of the testicle, with little tendency to suppuration, may be noticed. The pregnant female is apt to abort or miscarry. Fever of various types may attend this stage.

Gummata also occur in the internal organs (*visceral syphilis*), and of the latter I shall speak presently, taking up separately some of the various organs and systems of the body. *Amyloid degeneration* is frequently caused by the acquired form, particularly syphilis of the rectum in women, but very rarely by the congenital.

Malignant Syphilis.—By this term is meant a virulent and a fatal form of the malady which is fortunately rare. The various stages manifest themselves early, and especially the tertiary, as on the forty-fifth day in a case of Mauriac. The course is rapid and the condition resists all forms of treatment.

Roussel narrates a case in which death occurred about one year after the commencement of the disease.

Clinical Symptoms of Congenital Syphilis.—These may, though rarely, be identical with those of acquired syphilis, if we except the chancre.¹ Occasionally the characteristic symptoms are present at birth. On the other hand, in the vast majority of instances, they appear between the first and fourth months of life (*infra*). The symptoms of *inherited syphilis* may be grouped according to the time of appearance. Kassowitz states that one-third of all children procreated of syphilitic parents are born dead, and of those born living 24 per cent. die within the first six months of life.

(1) **In the Newborn.**—There is a lack of physical development. The babe may be *greatly emaciated*, it has snuffles, and singultus occasionally sets in soon after birth. Skin eruptions are rare except *pemphigus neonatorum*, which appears as bullæ on the palms and soles; among exceptional cutaneous phenomena are gummata around the radiocarpal articulations, palmar psoriasis, and a fleeting roseola. Ulcers and fissures (*rhagades*) may be noticed around the outlets of the body (mouth, anus, etc.); the osseous system may show hyperostoses of the long bones; and the liver and spleen are enlarged. Comby reports 8 cases of pseudoparalysis due to syphilis in the newborn.

(2) **Early Postnatal Symptoms.**—Most subjects of congenital syphilis are born *plump* and *without taint*. Symptoms appear in the majority of cases not later than the third month.

The first symptom is generally *coryza* (syphilitic rhinitis), which is betrayed by a seropurulent or bloody discharge and a peculiar form of *obstructed breathing* (snuffles), rendering nursing difficult. The coryza may in some cases be preceded by singultus lasting ten or twenty days (Carini), and ulcers may form in the nose, leading to necrosis of the bones and producing at last a sunken and deformed nose that is highly significant. The coryza may extend to the middle ear and cause otitis media, with deafness and otorrhea as the chief symptoms. The *skull* may approach the natiform in shape, and the signs of diaphyseal inflammation develop.

The *cutaneous symptoms* appear early. The skin has a tawny hue, and an erythematous eruption of the nates and genitals is frequently seen; this is patchy, with well-defined margins, and has the characteristic coppery color. In the same localities papules may appear, while pemphigus may attack the palms and soles. Syphilitic onychia may be present, and the lips and angles of the mouth often show fissures that are of real diagnostic worth. Other symptoms are ulcerations of the skin and mucous surfaces, falling of the hair, and a moderate glandular enlargement.

Enlargement of the spleen is a frequent characteristic symptom, and, according to White and Martin, of greatest importance "when noticed early—the first three months after birth—since at this period enlargement of the spleen due to rachitis can hardly come into question."

Swelling of the liver may also be present, but is of little diagnostic import. Syphilitic infants occasionally manifest a hemorrhagic tendency. At birth bleeding from the umbilicus may occur; later, into the subcutaneous tissue and from the mucous membranes (gastro-intestinal, vaginal, nasal, etc). Hecker considers an examination of the umbilical cord important for the early recognition of syphilis in the offspring of syphilitic parents; if the microscope shows characteristic changes, time may be gained for treatment; "these changes range from a decided endarteritis or periarteritis or phlebitis to a simple round-celled infiltration of the blood-vessel walls or the surrounding tissue." As

¹ With prenatal syphilis we are not concerned.

superficially, connecting directly or indirectly with the dura or pia mater. In gummata of average size a cut section shows caseation in spots which are connected and surrounded by firm, translucent, gray or reddish-gray, fibrous tissue; and the more irregular surfaces and the irregular caseation serve as important distinctions from tuberculous tumors. When, as is usual, the gummata touch the membranes, meningitis—subacute or chronic, with much thickening—is combined. Gummatous growths may attack the cord. They seldom attain a large size.

(3) *Endarteritis*.—This important lesion of syphilis may result in aneurysm, hemorrhage, or narrowing and obliteration of the lumen of the blood-vessels. As a consequence of the latter, areas of softening and secondary degeneration occur, varying in size with the distribution of the affected vessel. Thrombosis in cerebral arteries may be found. Similar vascular lesions occur in the cord.

(4) *Tabes dorsalis* (to be discussed in Diseases of the Central Nervous System).

(5) *General paresis* (to be discussed in Diseases of the Central Nervous System).

Etiology.—Cerebral syphilis is usually a late (tertiary) manifestation, appearing on the average three or four years after infection, but it may appear much sooner. After twenty years it is rare. R. W. Taylor has pointed out that syphilis of the nervous system is likely to appear in persons of a neurotic or neurasthenic constitution, particularly in those cases where the treatment required for the secondary period of the disease has been neglected or insufficiently carried out.

Symptomatology.—*Imbecility* and *idiocy* may be due to inherited syphilis, but they are probably too often attributed to this cause. The other features simulate those of the acquired form.

The *symptoms of the acquired form* are with few exceptions referable to three affections: (a) epilepsy, (b) brain tumor, and (c) paralysis.

(a) *Epilepsy* coming on after the thirty-fifth year, not dependent upon alcohol or uremia (p. 1157), is usually due to the ravages of syphilis, and a careful search for traces of scars and of the entire body surface for bone lesions, etc., should be instituted. Convulsions of the epileptic type have also occurred during or just before the advent of secondary symptoms. The appearance of the disease may be preceded by psychic disturbance, headache, dizziness, and loss of memory. Hysteric manifestations may also be presented, being probably provoked by the specific lesions. On the other hand, a protracted torpor which may last for a few days or as many weeks may develop. While in this stuporous condition the patient may wander aimlessly about. In one of my own cases periods of marked mental excitement that persisted for three or four days, alternated with periods of almost complete insensibility of about equal duration.

(b) *Brain Tumor*.—The symptoms pointing to brain tumor will be discussed under this head in the section on Nervous Diseases. The syphilitic nature of the cerebral growth cannot be determined with certainty except in the presence of a clear history of syphilis—congenital or acquired—and the characteristic symptoms or traces of the primary, secondary, or tertiary lesions.

It must be remembered that the secondaries are either sometimes absent or go unnoticed, and if the patient has had a primary sore, the presence of the characteristic symptoms of brain tumor (headache, optic neuritis, convulsions, etc.) make the existence of specific nerve lesions highly probable. The chancre may also be overlooked or denied, and it is in such instances as the latter that the occurrence of convulsions in persons over thirty should excite suspicion.

(c) *Paralysis*.—This may take the form of hemiplegia, due usually to cerebral thrombosis if of sudden advent (p. 1120), or if of gradual development to gumma (p. 1130), or of general paralysis (*dementia paralytica*). The relation that these affections bear to syphilis will be indicated in its appropriate place in this work in the description of Nervous Diseases. The fact may here be pointed out that syphilis may induce precisely the same changes met with in general paralysis of the insane (p. 1147).

The cranial nerves, especially the third, fourth, and sixth, are liable to be involved in syphilitic basal meningitis (p. 1079).

The history of syphilitic infection, together with symptoms of spinal tumor (p. 1099), points to *gumma* of the cord. Syphilitic myelitis usually develops in five years after the infection, and may pursue an acute or subacute course, though oftener it takes the form of chronic myelitis (pp. 1093, 1096). The latter attacks by preference the lumbodorsal section of the cord—a fact corroborated by the character of the symptoms, and in most cases is not a true inflammation, but is a softening due to thrombosis in some of the spinal arteries. A type described by Erb, and known as Erb's syphilitic spinal paralysis, presents rather characteristic symptoms. These consist of slowly increasing weakness and stiffness of the lower limbs, with increased reflexes and sometimes paresthesia of legs, back, and anal region. There is also some incoordination, and Romberg's symptom may be present. The gait is of the ataxic paraplegic type (p. 1108), and incontinence of urine and feces is usually present. Sensory paralysis is absent. A peculiar feature is that at rest the rigidity of the limbs is not marked, but becomes so when attempts to walk are made. The lesion is probably a thrombosis of the vessels supplying the posterior columns and pyramidal tracts.

General Diagnosis.—The onset in nervous syphilis may be acute or subacute, and the symptom-complex embraces a multiplicity of phenomena, there being an especially erratic distribution of the ocular and other attending palsies and early marked impairment of the mind, all occurring, as a rule, in *early adult life*. The symptoms, while they may simulate any of the various systemic and general diseases of the nervous system, are apt to present some atypical feature, and their development is frequently preceded by violent headache and somnolence. They are also frequently more or less transient and shifting. Examination of the cerebrospinal fluid for pleocytosis and increase in globulin, as well as the Wassermann test in both blood and fluid, is of service in doubtful cases. Lange suggests the colloidal gold test; "it is performed with cerebrospinal fluid, treated with a specially prepared gold solution, the specific reaction being a precipitation of the latter."¹ The cell count, the Wassermann reaction, and the other specific tests of the spinal fluid are of value not only in diagnosis but also should be carried out from time to time to control treatment.

Prognosis.—In acute cerebral syphilis with stupor this is bad. In other forms complete recovery may occur, but it is well to remember that where actual destruction of nerve-cells and fibers has taken place, removal of the lesion will not restore them, therefore it should always be guarded as to how much restoration of function will occur.

SYPHILIS OF THE LIVER

In my experience the liver, with comparative frequency, bears the stress of visceral syphilis. Syphilis of the liver occurs more frequently in men than in women, and, according to Peiser, appears most frequently in from five to fifteen years after date of infection.

¹ *International Clinics*, vol. iv, 25th Series, 1915, 15.

Pathology.—The lesions may be thus classified: (a) **Diffuse Syphilitic Hepatitis.**—This is met with chiefly in congenital cases. Though its occurrence in adult life has been questioned by some, I have seen an instance in an adult who died of cerebral hemorrhage. The liver is uniformly enlarged, firm, and resists the cutting knife. Its color is grayish yellow. The microscope shows a marked increase in the connective tissue and a cell infiltration throughout. From intense, focal cellular infiltration miliary gummata may result; these undergo contraction, diminishing somewhat the size and altering the shape of the organ.

(b) **Gummata.**—These may be seen in congenital cases (chiefly the miliary gummata). As seen in the adult, hepatic gummata are disseminated nodules, with the usual central, cheesy mass surrounded by a zone of grayish fibrous tissue and varying in size from a hazelnut to an apple. They form separate tumors whose favorite seats are the convex surface of the organ, especially near the suspensory ligament, and in the region of the portal vessels. They are usually tertiary lesions, and appear a number of years (two, three, or four) after infection. These so-called syphilomata in the advanced stage contract, and the liver will be found smaller than the normal. Deep furrows due to contracting fibrous bands traverse the organ in different directions and divide it into lobes of various dimensions. Gummata frequently undergo fibroid change, but more rarely they soften and liquefy (Wilks). On the other hand, before contraction occurs the liver is increased in size and the gummata form protuberances on its surface.

(c) **Gummatous Arteritis.**—Briefly, this may affect both the portal vein and hepatic artery, though syphilitic endarteritis is situated chiefly in the smaller branches of the latter.

(d) **Perihepatitis.**—Here Glisson's capsule is thickened, owing to augmentation of its connective-tissue elements. From the latter there dip into the hepatic tissue cicatricial bands, particularly along the portal canals, which may change somewhat the shape of the organ. Section shows admirably the pale scar-like tissue (*vide* Diseases of the Liver).

Clinical History.—The affection may exist without symptoms. In the *congenital form*, however, we have signs of hepatic enlargement, with icterus, the spleen being likewise large and firm, as a rule. The history and associated lesions are necessary to a certain diagnosis.

In the *adult* syphilis of the liver does not usually attract attention until the gummata interfere with the portal circulation. As they undergo contraction they tend to occlude some of the portal branches, or they may, on account of their situation, exert pressure upon the vena porta itself. In either event the evidences (ascites and splenic enlargement) of portal obstruction will develop as in alcoholic cirrhosis. The gastro-intestinal symptoms common to the latter disorder are also present, and obstructive jaundice may supervene, though it is, comparatively speaking, rare. Pain, usually localized to some particular spot over the right hypochondrium, is sometimes complained of, and may be quite severe, while pressure over the painful area elicits great tenderness.

Physical Examination.—In the early stage, while the organ is enlarged, flattened, irregular protuberances may be detected by the palpating fingers. These nodules, or large, round masses, invade especially the left lobe as compared with the right. At a more advanced period ascites may interfere with palpation, and in such cases an aspiration of the fluid will enable one to feel the syphilomata. Finally, in the stage of contraction the results of palpation are obviously negative.

There is a group of cases in which the clinical picture is that of *advanced*

amyloid disease of the viscera. The liver and spleen are enlarged, the urine is increased in amount and contains albumin and tube-casts, and finally dropsy supervenes.

Diagnosis.—This rests upon the etiology, the presence of scars on the skin surface, bone lesions (irregularities of the tibial surfaces) or other evidences of the ravages of the disease, and upon moderately good general health plus the positive Wassermann or luetin reaction. The most important local symptoms are the hemispheric prominences on the surface of the liver and the localized pain. The diagnosis between syphilitic disease of the liver and *echinococcus cysts* is sometimes extremely difficult. R. Lennhoff has noted in a number of cases of echinococcus cyst that on deep inspiration a furrow forms above the tumor, between it and the edge of the ribs.

The clinical findings resemble those of cancer of the organ. I have contrasted the main dissimilar points in the subjoined table:

SYPHILIS OF THE LIVER	CANCER
History of heredity or of infection.	Of heredity or of primary growth.
Occurs congenitally, or, if acquired, at any age.	Never congenital. Usually occurs after the age of forty.
Often accompanied by symptoms of tertiary syphilis—alopecia, rupia, etc.	Often preceded by the primary growth—pylorus, uterus, mammary gland.
Jaundice and ascites are common, especially the latter. No cachexia.	Jaundice and ascites are rare. Marked cachexia.
The margin is markedly irregular, and neither nodular nor umbilicated.	Often the margin reveals the presence of umbilicated nodules.
Recovery may follow, or the affection may last for years.	Always fatal. Duration usually from a few months to a year.
Wassermann usually positive.	Rarely so.

The **course** and the *results* of antisymphilitic treatment are of value for diagnosis. The course is slow and often interrupted, while appropriate treatment may lead to recovery, as in 3 of my cases.

SYPHILIS OF THE ALIMENTARY TRACT

The lesions in the mouth have been, for the most part, considered. In the tongue gummata often develop. A decidedly fissured appearance of the organ and whitish scar-like patches upon the surface may be observed in syphilis, but have no essential connection with that disease. Perforation of the palate due to tertiary lesions is not rare. Gummata also appear on the posterior wall of the pharynx and lead to ulceration, which may cause fatal hemorrhage by erosion of adjacent large blood-vessels (internal carotid, etc.). The walls of the esophagus may also be invaded, resulting usually in stenosis.

The stomach walls may be infiltrated and, rarely, ulcerated. Einhorn, Fournier, and others have met gastric ulcer in syphilis; it was cured by the specific treatment. This lesion is usually associated with deficient acidity, thus differing from ordinary gastric ulcer. Syphilitic tumor of the stomach may rarely occur; the symptoms are those of malignant growth, resembling cancer, but curable. Morgan¹ calls attention to the fact that the clinical manifestations of syphilis of the stomach are: (1) Chronic gastritis; (2) ulcer; (3) stenosis. The final diagnosis rests upon the serologic findings and the result of treatment. Bensaude and Rivet² call attention to the fact that mercury and iodids are well borne by the stomach when syphilis is causing the symptoms, whereas these drugs are taken with difficulty by the patient suffer-

¹ *Amer. Jour. Med. Sci.*, 1915, cxlix, 392.

² *Presse méd.*, 1919, xxvii, 621.

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second stage. Differentiation of syphilitic myocarditis is difficult, but Rosenfeld points out that low blood-pressure, symptoms of mild angina pectoris, dilatation of the left ventricle and aorta, constantly irregular pulse, and positive Wassermann sufficed in two instances. An assured diagnosis demands signs of cardiac disease with a positive Wassermann, and a response to anti-syphilitic treatment, which should be intensive. Sudden death may occur (35 cases—Huchard). In early cases of cardiac lues the prognosis is reasonably good under appropriate treatment.

(c) *Syphilitic Endocarditis*.—The changes are of the fibrosclerotic variety, and not of the acute verrucose type, involving in the great majority of cases the aortic valves. The symptoms to which the lesion gives rise are depicted under Organic Valvular Disease.

SYPHILIS OF THE ARTERIES

Two forms are recognized: (a) *Obliterating Endarteritis*.—Here the syphilitic product consists chiefly of proliferated subendothelial tissue, which encroaches more and more upon the lumen of the vessel—a fact to which the disease owes its name. This so-called “Heubner’s degeneration” is not peculiar to syphilis, but, as Osler says, “if, however, there are gummata in other parts, or if there be gummatous periarteritis in adjacent vessels, the process may be regarded as syphilitic.”

(b) *Gummatous Periarteritis*.—The arteries most frequently involved are those at the base of the brain. Charcot described a condition which he calls “syphilitic periarteritis,” where the tunics of the arteries are infiltrated with tumors or nodosities which the microscope showed were the result of an acute arteritis producing infiltration of connective-tissue cells into the tunica media.

Syphilis of the arteries has an important etiologic bearing upon mesaortitis and aneurysm (*vide* Diseases of the Arteries).

SYPHILIS OF THE KIDNEYS

Renal syphilis belongs chiefly to the tertiary stage, though it may appear in the secondary.

Pathology.—(a) *Amyloid degeneration* is a common renal lesion.

(b) *Chronic interstitial nephritis*.

(c) *Gumma*.

(d) Acute diffuse nephritis, occurring chiefly in second stage.

(e) Acute glomerulonephritis.

Symptoms.—Except in the case of amyloid degeneration the conditions are difficult of correct diagnosis. The occurrence of nephritis in a patient with a positive Wassermann and no other explicable cause for the nephritis would suggest a diagnosis largely by exclusion. Stengel and Austin¹ call attention to the fact that doubly refractile lipoids are abundant in the urine of nephritics with syphilis, rare and in small quantities in urine of other types of nephritics.

¹ *Amer. Jour. Med. Sci.*, 1915, cxlix, 12.

third, non-inflammatory nature, and fourth, raw ham or dark red color. In this connection two facts need to be emphasized, first, that a syphilitic eruption, either macular or papular, never causes troublesome itching; and second, that a patient with a syphilitic eruption may experience itching due to another cause—namely, eczema or scabies.

Inherited syphilis may be diagnosticated on the appearance in a child under five months of snuffles and the characteristic skin eruptions. *Syphilis hereditaria tarda* may be recognized either from a retrospective view or from the presence of active lesions and symptoms.

Tertiary manifestations of acquired syphilis embrace these points: 1. The consideration of the fact that obscure cases in general and atypical symptom-groups are often due to the syphilitic taint. 2. Direct information or proof, as the result of careful inquiry, to show that the primary and secondary stages (either one or other, or both) have transpired. 3. The evidence presented by the patient and to be obtained by the careful objective examination of the eyes (for iritic adhesions, etc.), throat and skin (for scars), bones (for necrosis and nodes), and the testes. 4. Certain symptoms are significant, such as nocturnal pains, paralysis of the single cranial nerves, double deafness without otorrhea, etc. 5. The therapeutic test may aid in doubtful cases. 6. The Wassermann reaction, if positive in cases such as these, must be considered as absolute in confirming a diagnosis of latent tertiary syphilis.

The presence of scars constitutes a most important factor in making a retrospective diagnosis. Recent scars are pigmented, and exhibit a slow, progressive clearing up, until, from four to eight years after infection, they are wholly decolorized, pearly white in color, and smooth. On the other hand, as pointed out by Hyde, eczemato-varicose scars remain stationary. These scars are apt to be found on the scalp and on the anterior surfaces of the legs. They may be single or multiple, and may exhibit certain defined shapes (semilunar, dumb-bell, etc.).

Both inherited and acquired syphilis can now be recognized by the serum reaction of Wassermann. The reaction is positive in 70 to 80 per cent. of cases in the first stage; 95 to 98 per cent. in the second stage; 30 to 80 per cent. of latent syphilis, depending on thoroughness of treatment; 90 per cent. of late untreated or tertiary syphilis; and 90 to 95 per cent. of congenital syphilis. Obviously, the Wassermann reaction is of the greatest necessity and diagnostic importance in cases in which syphilis is not recognizable by the ordinary methods of examination—*e. g.*, cerebral or spinal syphilis, syphilis of bones and the internal organs. The reaction depends upon the fact that syphilitic blood-serum will so breed complement when certain lipoids or extracts of various organs (often cholesterinized the antigen) are present; that if a hemolytic amboceptor (the blood-serum of rabbits after repeated injections of washed blood-cells) and washed sheep blood-corpuscles are added, hemolysis of the red cells does not take place. The blood is collected by inserting a small calibered needle in one of the veins at the bend of the elbow, which is made to stand out prominently by tightening a tourniquet above the elbow sufficiently tight to obstruct the veins but not to obliterate the pulse. About 15 to 30 c.c. of blood are collected under aseptic precautions in a sterile test-tube, which can then be sent to the laboratory for examination.¹ Schmidt recommends that in syphilis of the nervous system the Wassermann reaction should be done with the cerebrospinal fluid as well as with the blood-serum. Kolmer and others contend that the venom hemolytic test is distinctly inferior to the Wassermann reaction. Robinson contends that the Noguchi luetin reaction (intradermic

¹ Wassermann's reaction is quite complicated, and for the details of the method itself, the reader must consult special works on diagnosis.

demands that prostitutes shall be officially registered. Such a sanitary supervision should consist in the examination of every prostitute at least twice a week, including a microscopic examination of the uterine and vaginal secretions, and the sending of every diseased prostitute to a hospital with a special department for such cases.¹ Palmer suggests that the female offender is usually not aware of the existence of a primary sore, while the male is; hence the latter should undergo inspection also. Inspection of prostitutes, however, unless rigid and careful, is absolutely valueless. Chancres are often concealed from view in the vagina or upon the lateral aspect of the os uteri. The maintenance of legal brothels, however, is not here recommended, either from a moral or hygienic standpoint. Experiments have shown that the application of 30 per cent. calomel ointment within an hour of inoculation is preventive of infection in man (Metchnikoff and Roux).

Another social question of great prophylactic import is whether syphilis should be made a reportable disease, as are all other communicable diseases except gonorrhea, in enlightened and civilized communities. Undoubtedly the time is fast approaching when such a measure will be required in order to protect the community adequately against the dangers of this scourge. In western Australia a radical measure was put into effect December, 1915, which requires not only that the disease must be reported to the health authorities but also that the infected person must undergo, under compulsion, treatment until he is free from contagion.

(b) **Medicinal Treatment of Hereditary Syphilis.**—For syphilis of the newborn, mercury by inunction or in the form of calomel (gr. $\frac{1}{16}$ —0.064 t. i. d.) or gray powder (gr. $\frac{1}{2}$ —0.032 t. i. d.) is to be employed. If these babies must be hand-fed the issue is almost unexceptionally bad.

When the first symptoms appear at the second or third month the above method of treatment is generally successful. Among the poorer classes no objection is made to mercurial inunctions, and these are preferable. The ointment may be rubbed into the armpits, thighs, or sides of the abdomen, which should be covered with a flannel roller, or the ointment may be placed under the baby's binder and replaced every twenty-four hours. The parts must be kept clean, and the mouth washed after nursing with a 3 per cent. solution of boric acid. Shaw prefers to treat infantile syphilis by inunctions because of the digestive disturbances usually following the internal administration of mercury to children. Late congenital syphilis is best treated by the use of potassium or sodium iodid. To the iodid may be added mercuric chlorid in suitable doses, though the latter may sometimes disagree (Roberts). In addition to the specific therapy tonic measures are usually indicated.

(c) **Treatment of Acquired Syphilis.**—The plan of treatment consists, in general, of first a course of arsphenamine for six to eight weeks, followed by mercurial treatment for the same length of time, and then a repetition of these two drugs until the Wassermann becomes negative. Wassermans are then taken at intervals of one, two, six, and twelve months. If the reaction becomes positive it is the signal for resumption of the treatment.

Mercury will be considered first of these two drugs because its history as a spirocheticide has been long and honorable.

For *internal use* the preparation of choice is the protiodid (gr. $\frac{1}{8}$ to $\frac{1}{3}$ —0.008–0.021—three times a day) and later the biniodid (gr. $\frac{1}{36}$ to $\frac{1}{24}$ —0.0021–0.0027—three times a day). We should begin by giving one pill three times daily, and increasing one pill each day until the premonitory symptoms of ptyalism appear (tenderness when the teeth are knocked together and ropy

¹ *Brit. Med. Jour.*, November 22, 1913.

saliva); then the pills should be reduced one-half or one-third, depending upon the number taken.

Inunctions of mercurial ointment (3ss—2.0) night and morning produce excellent results, and it is advisable in cases in which the syphilids yield unsatisfactorily to internal dosage to suspend the latter at intervals of six or eight weeks and give a course of twenty inunctions.

The *hypodermic* use of mercury in syphilis had been at one time extensively adopted. Salicylate of mercury offers the most satisfactory remedy for hypodermic medication. It should be administered in doses of 1 to 2 gr. (0.06–0.13) twice a week. All injections must be made deeply into the muscles.

It is almost universally agreed that arsphenamine offers incredible possibilities in the treatment of syphilis, and yet the immense majority of writers are of the opinion that it should not be used in every instance of the disease nor used without a supplementary mercurial treatment. The question of its permanency of curative action has not, as yet, been definitely settled.

The method of injecting the drug in neutral suspension or emulsion subcutaneously gives less permanent results than by the other methods, and has been almost completely discarded. The technic for intramuscular injection of an alkaline solution is as follows: Take a graduated cylinder with ground-glass stopper, add salvarsan; immediately add 15 c.c. hot water, shake vigorously until every particle of the salt is dissolved; then add 2 c.c. normal hydrate (NaOH) solution; a precipitate occurs. Then continue to add sodium hydrate solution in very small quantity, shaking vigorously after each addition, until the solution begins to clear; then drop by drop, until we have a clear solution. This should be neutral or slightly alkaline; if the cylinder does not contain 20 c.c. of solution, sterile water is added up to that amount. Then 10 c.c. of this solution is injected deep into the buttocks on either side, always taking care to cleanse the parts with soap, water, and iodine.

The *intravenous method* of injecting the drug is so simple and yet so satisfactory that it is now the only method employed, at least by competent syphilographers. For the administration of the substance a gravity buret with a rather short rubber tube connecting the needle is all that is required. To 150 c.c. of sterile water the arsphenamine is added. To this solution is added drop by drop normal sodium hydrate until a precipitate is formed, which is subsequently redissolved by continuing to add the alkaline solution until the whole solution is clear. The injection is now ready to be given. The patient's arm is bared and a tourniquet placed well up the arm sufficiently tight to make the veins stand out, but not so tight as to obliterate the radial pulse. The skin over the bend of the elbow is then sterilized by application of tincture of iodine, followed by alcohol. The air is then forced out of the rubber tubing by allowing the solution to run until it begins to drop from the needle, and the needle inserted into the vein. If a small piece of glass tubing is inserted into the rubber tubing as a connection about an inch from the needle it will aid in telling when the needle is in the vein, because when the vein is entered there will be a gush of blood into the needle and tube which may be seen in the glass tubing. The tourniquet is now released and the arsphenamine allowed to run into the vein very slowly. The amount of arsphenamine given at each dose varies somewhat. In general, 0.1 gm. for each 25 pounds of body weight up to 0.6 gm. may be given.

Neo-arsphenamine has the great advantage of being able to be given in much greater concentration, so that it may be injected in a small amount of water, 10 to 20 c.c., with an ordinary piston syringe. The average dose of this preparation is 0.9 gm. The solution should always be absolutely clear.

In regard to the frequency of injection, it is customary to give arsphenamine

weekly for six to eight weeks or until the Wassermann is negative. Neo-arsphenamine may be given as often as three times a week in early cases of syphilis.

Which preparation to employ is still an open question—arsphenamine has undoubtedly greater curative powers than neo-arsphenamine. On the other hand, it is more toxic, less readily administered, and varies more in hydrogen-iron content than neo-arsphenamine (neo-arsphenamine has essentially the same hydrogen-iron concentration as the blood), while more reactions have occurred after its use than with neo-arsphenamine. Schamberg¹ well sums up this question when he says that there has been no rigid and extended comparative test of the two compounds on a large series of patients with careful data on the serologic end-results.

The reaction to the drugs is usually nil. Occasionally there is some slight nausea or vomiting, a rise in temperature of a degree or so. Very rarely indeed do severe immediate reactions occur, manifested by syncope or by chill, sharp rise in temperature, skin rashes, diarrhea, great prostration, and in still rarer cases death. Stokes and Busman² hold that the introduction into the body of some toxic constituent of new rubber tubing through which the arsphenamine flows is responsible for the reaction. Schamberg and his co-workers³ attribute the reaction to traces of some unidentified impurity, called by them substance *x*. At times several days after the injection severe jaundice may occur. Lynch and Hoge⁴ attribute this to an intoxication such as occurs in acute yellow atrophy of the liver. In the several cases that Musser has seen his studies led him to believe that the jaundice was hemolytic in character and caused by the hemolytic action of the drug.

The remedy is contraindicated in non-luetic retinal and optic lesions, chronic Bright's disease, the acute infections (including bronchitis), pulmonary disease (except tuberculosis), and advanced diseases of the brain and cord. A patient should not be pronounced cured until he has continued free from all signs, including a negative Wassermann, for at least a year after suspension of treatment in primary cases and two years in secondary cases.

Recently reports⁵ of a new arsenic preparation, N-phenylglycine-P-arsonic acid, have appeared in the literature. It is said to be of value not only in spirochetal infections but also in trypanosomiasis.

Hygiene plays no mean rôle in the successful management of syphilis. The diet must be liberal. Alcohol and tobacco are the two great enemies of the luetic.

Auxiliary measures, when other lesions are associated, are important. Anemia and debility call for iron and a tonic plan of treatment generally. Attention should be given to the stomach, bowels, kidneys, and other organs. At all times it should be borne in mind that the patient, as well as the disease, is to be treated.

In *women* the iodids should be suspended during menstruation if the flow of blood is excessive. Says Mauriac: "During pregnancy specific treatment is well tolerated, and often requires to be pushed to a point a little short of intoxication for the good of both the mother and the child, close watch being kept upon the kidneys, suspending treatment at the first sign of albumin."

(d) **Treatment of Tertiary Syphilis.**—For most tertiary manifestations, including visceral syphilis, we have a specific in potassium iodid for the removal of gummatous lesions (Jobling and Peterson).⁶ I give the potassium iodid in a

¹ *Jour. Amer. Med. Assoc.*, 1919, lxxiii, 1883.

² *Ibid.*, 1920, lxxiv, 1013.

³ *Arch. Dermat. and Syph.*, 1920, xxxviii, 235.

⁴ *Jour. Amer. Med. Assoc.*, 1919, lxxiii, 1687.

⁵ Pearce and Brown, *Jour. Exper. Med.*, 1919, xxx, 437, 455, 483.

⁶ *Arch. Int. Med.*, 1915, xv, 286.

and terminating by lysis. These febrile attacks may recur after intervals of varying duration. Nausea, vomiting, and diarrhea may rarely occur. Hemorrhages, varying from small ecchymoses to alarmingly large losses of blood, are frequent findings. The liver and spleen are often enlarged, the latter being tender on pressure. The urine is febrile, high colored, and often shows the presence of spirochetes, albumin with tube casts, and sometimes blood (hemoglobinuria). Anuria, according to Nolf and Firket,¹ who studied carefully 100 cases, is a fairly constant symptom. This is frequently not characterized by signs of kidney involvement, but was attributed by the observers to the extremely low blood-pressure seen in some of these patients. In grave (but rare) cases cerebral symptoms, such as delirium, convulsions, and coma, may occur and prove fatal.

The **diagnosis** rests on the acute onset, fever, pains in the muscles, joints and epigastrium, nephritis, and icterus. Schlamffieber, which prevailed mainly among young persons who had worked in the recently flooded districts near Breslau during the summer of 1891, and assumed epidemic proportions, has not been satisfactorily classified. Müller shows its resemblance in many respects to Weil's disease, which may occur at times without jaundice (?). Martin and Pettit² have shown that specific agglutinins appear in the blood by the tenth day of the disease and last for months. Normal and syphilitic sera do not agglutinate the spirochetes of infectious jaundice.

Prognosis.—The European disease gives a mortality not exceeding 2 or 3 per cent., while in Japan it is higher, averaging 38 per cent. W. E. Hughes records 2 cases that proved fatal within forty-eight hours of the onset.

Treatment.—The diet should be fluid, such as milk, broths, and the like. Hydrotherapy is indicated in the more toxic cases. The muscular pains may be relieved by warm stupes and fomentations. An intravenous injection of a 10 or 30 per cent. solution of glucose has been advised. Inada and his assistants have treated the disease in Japan with serum from convalescents or an immune horse-serum, injecting from 40 to 60 c.c., with disappearance of the spirochetes from the blood in twenty-four hours.

BRONCHIAL SPIROCHETOSIS

In 1905 Castellani first described bronchospirochetosis.³ The onset was with a chill and high fever lasting four days. At the end of one month there was only a dry cough with serous and bloody expectoration. The microscope showed the sputum swarming with spirochetes. To these spirochetes Castellani has applied the name *Spirochæta bronchialis*. This spirochete is Gram-negative, but takes with avidity the ordinary anilin stains.

Thomson⁴ has met with pulmonary spirochetosis in a chronic form, some of the cases simulating tuberculosis; others, malaria. The bronchial lesions did not appear to be serious. In this chronic form the cough is the chief complaint. It is persistent over long periods, occurs most severely upon arising and toward night, and is accompanied by fairly profuse mucopurulent sputum, which is at times bloody. The *diagnosis* depends upon finding the spirochetes in the sputum. The *treatment* has thus far been symptomatic.

¹ *Arch. méd. Belges*, 1918, lxxi, 380.

² *Bull. soc. méd. d. Hôp.*, 1918, xlii, 672.

³ *Anales de la Facultad de Medicina*, Lima, Sept.-Oct., 1918, 11, 141.

⁴ *Brit. Med. Jour.*, Dec. 28, 1918, p. 709.

THE SPIRILLOSES

RELAPSING FEVER

Under this heading are included numerous infections caused by many different species of spirilla. The first, the best known, and most completely studied of these is the infection known as relapsing fever, caused by the *Spirillum obermeieri* (*Spirochæta recurrentis*). For that reason it will be discussed fully, while the others will be alluded to but briefly, bearing in mind that all spirilla infections run somewhat similar clinical courses.

Definition.—An acute infectious disease caused by the spirillum of Obermeier, and characterized by febrile periods which usually last six days, and are separated by an afebrile period of the same duration. Manson suggested the term *spirillosis* for this disease, since "relapsing fever" covers "a number of infections, spread probably by a corresponding number of previously unsuspected ticks or blood-suckers."

Historic Note.—The first accurate account of this affection was published in 1739, though it is known to have prevailed in Europe and Ireland prior to that period. During the next century numerous epidemic outbreaks, more or less extensive, occurred, and in 1844 the disease made its first appearance in America at the Philadelphia Hospital, being brought by immigrants from Ireland. Subsequently small groups of cases occurred, and were reported by Flint and others, and in 1869 it prevailed considerably in Philadelphia (where it was studied especially by E. Rhoads and William Pepper) and in other large cities of the country. This was the last appearance of the disease in the United States.

Pathology.—The solid organs of the body present no characteristic anatomic changes, though when death occurs during the febrile period the various viscera (heart, liver, kidneys) are the seat of cloudy swelling, and some-

Fig. 30.—Bacillus of relapsing fever (from human blood); $\times 1000$ (Günther).

times of hemorrhagic infarct and extravasation. The *spleen* shows the most constant alterations, being enlarged, but in size it exhibits a great variability. Infarction is frequent, and the lymphoid element of the bone-marrow often shows hyperplasia.

Etiology.—Bacteriology.—In 1873 Obermeier discovered in the blood of patients suffering from relapsing fever a special organism, the *Spirillum obermeieri*, until recently classed with the bacteria, but now placed by Schaudinn and others with the flagellate genus *Trypanosoma*. It is a delicate filamentous organism of spiral form and much elongated, its length equaling four to six times the diameter of a red blood-corpuscle (Fig. 30). Examined under the microscope during a pyretic period, it is seen to exhibit active motion among the blood-cells, this motion being spiral and following the long axis of the organism. It is *aërobic*, and may best be demonstrated in *dry blood* by staining with Wright's stain. It is apparent in the blood only during the paroxysms, and Dr. Van Dyke Carter's careful studies have shown that by inoculation of the blood containing spirillar organisms the disease may be conveyed to new or old subjects. Shortly before the crisis the spirilla disappear from the blood,

and are, as a rule, absent during the whole of the succeeding apyrexial period. After death they are found in all the organs, but they have not been cultivated successfully on artificial media.

Predisposing Causes.—*Age.*—The complaint is most common in young adults between fifteen and twenty-five years.

Sex.—A larger proportion of males than females is affected.

Famine and antihygienic surroundings are potent predisposing causes.

Mode of Infection.—Tiotin's studies indicate that the medium of transmission may be through suctorial insects (as bedbugs). Mackie observed an epidemic of relapsing fever in which the *Pediculus corporis* played a part in the transmission of the disease. A well-marked percentage of the lice taken from the infected ward contained multiplying spirilla. During epidemics nurses and physicians are frequent sufferers, and there is some evidence that the disease may be conveyed by fomites.

Clinical History.—The incubation period ranges in its duration from four to ten days, though sometimes it is even briefer; and in this stage certain symptoms (malaise, fugitive pains) may appear.

The invasion is *abrupt*, often occurring on awakening in the morning, and commonly the attack is ushered in with a severe *rigor*, though there may be only a repeated slight shivering. The chief accompanying symptoms are frontal headache, vertigo, severe pains in the loins and limbs, and marked prostration. The *temperature* rises soon, and often rapidly, reaching 105° to 106° F. (40.5°–41.1° C.) on the first or second day. The *skin* is dry and pungent, and presents very soon either a "characteristic dirty yellow color" or a distinctly bronzed appearance. The *cheeks* are flushed, the eyes sunken, and profuse perspiration often takes place, in consequence of which sudamina are frequently observed. Other forms of eruption have been described, but none that are either constant or characteristic. In certain epidemics *herpes labialis* has been noticed. At first the *tongue* is moist and coated with a yellowish-white fur, and later it may become brown, dry, and fissured, with sordes on the teeth. *Ulcerative stomatitis* has been observed occasionally, and catarrhal pharyngitis and mild tonsillitis may be evidenced by pain on swallowing. Among the earlier symptoms are excessive thirst, anorexia, nausea, and vomiting. The vomitus may be yellowish-green, green, or even black in color, and consists partly of bile (rarely, also, blood) and gastric secretions. Constipation often precedes invasion, and is apt to continue throughout the attack.

The *pulse* rises rapidly with the temperature, though the normal ratio between the two is not maintained. The pulse is full and strong, and its beats number from 100 to 140 or more per minute; but in serious cases it becomes weak, irregular, or even intermittent, while at the same time the heart sounds grow more and more indistinct. Hemic *murmurs* may be audible. The *nervous* manifestations are not of a grave character, but the headache persists, is severe throughout, and the patient is restive and sleepless. Delirium is not common except only in rare cases toward the crisis, and the intellect remains clear, as a rule. The *urine* presents the ordinary febrile characteristics, and may contain albumin and casts. It also contains bile-pigment when jaundice is present. The *respirations* are accelerated, and urgent dyspnea may precede the crisis.

The **physical signs** during the febrile paroxysms are few. The epigastric region and the nerve-trunks are tender to the touch, while the skin surface and certain muscles are often hyperesthetic. *Palpation* detects a variable degree of enlargement of the spleen and liver, and the signs of bronchitis, of lobular pneumonia, and of hypostatic congestion of the lungs may be present.

The symptoms above detailed persist with slight daily fluctuations of temperature until the crisis.

The Crisis.—This occurs from the fifth to the seventh day, and rarely as late as the tenth. It is sometimes heralded by a critical rise of temperature, the mercury touching 108° F. (42.2° C.), but evidenced chiefly by a rapid fall of temperature (within twelve hours) to or below the normal, with profuse sweating. Coincidentally, all other symptoms disappear with marvelous rapidity. The critical sweat may be replaced by diarrhea, intestinal hemorrhage, metrorrhagia or epistaxis, and after the lapse of a day or two the patient expresses himself as being well.

During the *intervals* between the paroxysms the skin may exhibit a faintly jaundiced tint; there may be trivial evening exacerbations of temperature, particularly if complications be present and outlast the fever stage; and the spleen is evidently enlarged. There may be, rarely, but a single paroxysm. As a rule, at the expiration of the second week, a recurrence of all the active symptoms of the primary attack occurs, including the rigor and fever. Quite frequently a third pyrexial stage takes place, and rarely a fourth or even fifth.

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20

Fig. 31.—Temperature-curve of relapsing fever.

The duration of the first relapse is briefer than the primary pyretic stage, and if there be subsequent relapses, each succeeding one is separated from its predecessor by the usual apyrexial period, but is briefer and lighter. Hence, should a fourth or a fifth febrile period occur, it is, as a rule, quite rudimentary. The relative duration and severity of the different febrile periods, and their manner of recurrence, are best appreciated by a glance at the temperature-chart (Fig. 31).

Complications.—These are not frequent. At the head of the list stands *lobar pneumonia*, and next come *bronchopneumonia*, which is always secondary. Rupture of the spleen may occur. Other complications are septicopyemic processes, hemorrhagic nephritis, hematuria, iritis, iridochoroiditis, parotitis, laryngitis, enterocolitis, and neuritis. In pregnant women abortion may take place. Epistaxis has been noted, and may prove dangerous. As the result of the very high temperature and toxemia the heart may become suddenly paralyzed.

Clinical Varieties.—The difference in the general course of cases in different epidemics, and even in the same one, is, for the most part, the direct

result of the varying degrees of intensity of the infection. Thus very *light* or even rudimentary cases occur in which the whole course may be made up of one or two brief febrile periods, and their resemblance to ordinary intermittents may be close. The so-called *bilious typhoid*, which is a form of relapsing fever, occupies the other extremity, being of malignant type. The symptoms are greatly intensified; but more often, perhaps, the condition early merges into a typhoid state, to which are added certain grave features and complications (marked icterus, hematemesis and hemorrhages from other outlets of the body, uremia, sudden collapse, etc.). Septic and pyemic processes, including infarctions, are common accompaniments, and the outcome is frequently unfavorable.

Mention has already been made of the fact that the *Spirillum obermeieri* is responsible for the ordinary relapsing fever of Europe. The many other types of tick and relapsing fever that are found elsewhere have been found to be due to other species of spirilla. These species vary morphologically somewhat, give different results when injected into animals, and have entirely different agglutinative properties. The spirilla may be transferred by the tick or the louse. The *tick fever of West and East Africa*, due to *Spirillum duttoni*, the virus of which is inoculated by scratching, is characterized by great pain in the spleen and vomiting at the onset, numerous relapses, and extreme prostration of the patient. The *relapsing fever of America*, due to *Spirillum nortyi*, is essentially similar to the European type, and, like it, the vector is the louse. The *recurrent fever of Bombay*, due to *Spirillum carteri*, is an extremely serious type of spirilla infection. It occurs in two varieties, a form simulating malaria and one closely resembling severe typhus infection. The *recurrent fever of Algiers*, due to *Spirillum berbera*, is a mild type of infection with, however, occasional cases having symptoms simulating cerebrospinal meningitis. The *recurrent fever of Tonkin* is a type of the disorder caused by the most virulent strain of spirilla. The symptoms are extremely severe and death occurs in about 27 per cent. of the cases. The disease is frequently associated with marked hemolytic manifestations, jaundice, purpura, subcutaneous hemorrhages, and so on. In other cases the symptoms are comparable to a severe typhoid infection.

Diagnosis.—The prevalence of an epidemic in which the cases present similar symptoms; the sudden onset; the course and intensity of the fever with its concomitants; the termination by crisis on or about the seventh day; and the peculiar manner of repetition of the fever attacks after an afebrile period of equal duration—are points that distinguish relapsing fever from other affections which simulate it more or less closely. Additional symptoms that are of special value for diagnosis are: enlargement of the spleen and liver, a negative character of the nervous and a prominence of the gastric phenomena, and jaundice. To be able to state that relapsing fever is positively present the *Spirochæta obermeieri* must be found in the blood, and this is particularly true in the earlier cases of an epidemic, before they have passed through their typical relapses. To demonstrate the presence of this parasite in the blood during the fever stage is not a difficult task. A drop of blood obtained from the finger-tip is to be examined microscopically without previous dilution. On account of their size and motility the spirilla can be readily detected, and usually the attention of the examiner is first arrested by the peculiar joggling movements of the red blood-corpuscles. Then the real disturbing agents appear as slender spirals with a snake-like motion. Their identity may be confirmed by staining with anilin colors, and, in exceptional cases, by injecting them into the blood of the monkey, in whom they produce the disease.

Differential Diagnosis.—*Typhus fever* may be mistaken for relapsing fever, since both have the same predisposing causes, both prevail epidemically,

PART III

DISEASES OF METABOLISM

DIABETES

(*Diabetes Mellitus*)

Definition.—A disorder of metabolism, attended by an abnormal amount of sugar in the blood, and characterized clinically by persistent glycosuria, by polyuria, and by a progressive loss of flesh and strength.

Pathogenesis.—This is still undetermined. Postmortem lesions of different organs and structures of the body have been met with in diabetes—a fact that has given rise to a variety of views.

(1) That it is dependent upon *organic disease of the pancreas*, especially the granular atrophy, or upon marked functional disturbance of this organ. It has been shown experimentally that extirpation of the pancreas is followed by diabetes unless aberrant “islands” in the intestines be present, and that if a portion of the gland remains glycosuria does not result. MacCallum says that Cecil found pancreatic lesions in more than 87 per cent. of diabetic post-mortems, the islands of Langerhans being always affected.

Lepine and Martz have been able to produce a glycolytic ferment by treating the pancreas after their own special method, which need not be detailed here. It is probable that the pancreas, and particularly the cells forming the islands of Langerhans, furnishes an internal secretion containing a glycolytic ferment. This ferment is identical with that which is contained in the blood, and in the presence of which glycogen is assimilated. Although the pathogenesis of diabetes is not yet fully understood, the consensus of present-day opinion would seem to hold that true diabetes is dependent upon a disturbance of pancreatic function; other factors in the production of glycosuria (*vide infra*) probably do not produce a true diabetes with its intense metabolic changes, but rather represent disturbances of carbohydrate tolerance of minor import with a consequent symptomatic glycosuria.

(2) The secretion of the posterior lobe of the *pituitary gland* is discharged into the third ventricle, and Cushing has shown that any disturbance, operative or otherwise, of the flow is at once followed by glycosuria and by a remarkable lowering of the assimilation limit for sugars. Anders and Jameson¹ collected a total of 246 cases of hypophyseal disease, and in 183 the urinary findings were mentioned and showed 28 instances of glycosuria, in 9 of which the condition was intermittent. Contrary to the opinion of certain writers, pituitary glycosuria without acromegaly may occur (in 10 of our series as against 16 in which acromegaly was also associated).

(3) The *suprarenal glands* have assumed a rôle of much importance since the valuable researches of Herter. He found that a solution of adrenalin chlorid injected into dogs or painted on their pancreas caused marked glycosuria. Other reducing substances acted in a similar manner. On the other hand, excision of the left suprarenal gland with ligation of the blood-vessels of the

¹ *Amer. Jour. Med. Sci.*, September, 1914.

hans. These peculiar structures appear to have a different function from that possessed by the other pancreatic cells, and are probably the source of the internal secretion of the pancreas. In *chronic interstitial pancreatitis* of the *interlobular* type the islands of Langerhans are affected only late, and glycosuria is rare. The changes following occlusion of the pancreatic duct by calculus, growths, etc., are of this variety. In the *interacinar* type the cells forming the islands of Langerhans are affected early, hyaline degeneration of the capillaries may be seen, and there is frequent and early glycosuria. In Herter's experiments the injection of fatal doses of adrenalin was followed by granular degeneration of the islands of Langerhans.

Acute necrosis of pancreas, primary cancer, and diffuse cancer may cause glycosuria, but rarely. The *liver* is often enlarged and fatty, particularly the zones corresponding to the distribution of the hepatic artery. According to French writers there is a diabetic cirrhosis of the organ (*cirrhose pigmentaire*), the pigment being derived from destroyed blood-cells. *Microscopically*, the liver-cells are found to be enlarged, nucleated, and globular in outline. Rindfleisch holds that these changes are most striking in the peripheral portion of the lobule.

The Kidneys.—A well-marked chronic interstitial nephritis, with fatty degeneration, is often present. The tubal epithelium and the vessels of the malpighian bodies may show a hyaline change. More commonly the appearances are those of an ordinary catarrhal nephritis.

Nervous System.—In rare instances organic disease of the medulla (tumors, sclerosis, etc.) is found. Changes in the posterior columns of the cord have been noted, and a peripheral neuritis, simple or multiple, is commonly seen. The so-called *diabetic tabes* is generally supposed to be due to multiple neuritis. Extreme hyperemia and edema of the meninges was found in all of 8 cases of diabetic coma (Hanssen).

The Lungs.—The commonest lesions in the lungs are gangrene following pneumonia and the so-called diabetic phthisis. Fatty emboli are found in the pulmonary vessels.

The Heart.—Arteriosclerosis with cardiac hypertrophy is often met with, but does not constitute a peculiar lesion.

The Skin.—Cutaneous pigmentation (diabetic bronze of the French), more or less uniform, has been reported in 9 cases (Hanot and Chauffard). It is associated with hypertrophic cirrhosis of the liver.

The Stomach.—Dilatation and, according to Jacobson, marked catarrhal changes are common in the early stage.

The Blood.—The recently devised microchemical methods of determining the sugar content of the blood has thrown much light on some of the fundamental problems of diabetes. It has been shown that the blood-sugar of the normal fasting individual varies between 0.08 and 0.10 per cent. The ingestion of carbohydrates is followed by a rapid rise in the blood-sugar content, reaching its maximum in one-half hour, and again becoming normal in about two hours. If the blood-sugar reaches 0.17 to 0.18 per cent. (Hamman and Hirschman),¹ sugar is excreted by the kidney—the kidney threshold. In the diabetic the blood-sugar never reaches the normal, and after a carbohydrate meal takes a long time to reach the lowest level attainable. The renal threshold may be considerably higher, furthermore, than in the normal individual. Thus the blood-sugar may reach 0.35 per cent. (Foster and Davis)² without glycosuria; or 0.4 per cent. or more blood-sugar may be present with

¹ *Proceedings Amer. Soc. Clin. Investigation*, 1916, p. 27.

² *Ibid.*, p. 28,

only a comparatively small quantity of sugar excreted.¹ Mosenthal and his associates claim that the maximal percentage of blood-sugar occurring in diabetic individuals in a carbohydrate-free diet, or one containing a moderate amount of starch, can be obtained by making the determination one or two hours after breakfast. Bloor has shown that the blood lipoids are increased in direct proportion to the severity of the diabetes, so that in severe cases the increase may be up to 100 per cent. or more of the normal values. The alkalinity of the blood is diminished, probably owing to the presence of acid. The corpuscles show no special alterations.

General Etiology.—(a) *Heredity* is generally believed to exert a predisposing influence, since cases are observed to succeed one another in the same family (in 40 per cent. out of 300 cases—Williamson). (b) The *male sex* suffers much more frequently than the female. Wegeli, however, found in 107 cases that children of both sexes were affected in an equal proportion. (c) *Age*.—Most cases occur between thirty-five and sixty years of age. Infantile diabetes is rare, and occurs most frequently about the age of five, though it has been met with under one year. The severity of the affection is usually in direct relationship to the age of the patient. Diabetes is severe in the young, relatively innocuous in the aged. (d) The *Hebrew race* is especially susceptible. The colored race rarely suffers, although of a series of 77 cases, 8, or 10.3 per cent., were in negroes (Futcher). There are few diabetics among the Japanese, whose chief diet is of a starchy nature. (e) The *better classes* of society furnish most instances. (f) A *nervous shock* or strain or prolonged mental anxiety acts as a predisposing cause. Severe emotion, exemplified in fear, rage, and pain, produces an increased discharge of epinephrin into the blood and temporary glycosuria.² (g) *Occupation*.—The urine of 607 individuals engaged in manual labor that required great muscular and respiratory activity showed no sugar in any case; while the urine of 100 individuals engaged in intellectual work of a more or less fatiguing character, but always intense and sedentary, showed sugar in 10 of the cases (Worms). (h) *Obesity* predisposes somewhat. (i) *Certain chronic diseases*—*e. g.*, syphilis, malaria, gout—predispose. Warthin and Wilson³ think it probable that latent syphilis is the chief factor in the production of diabetic pancreatitis. On the other hand, Williams⁴ observations indicate that syphilis is rarely the provocative agent. (j) *Pregnancy* has a slight though decisive influence. Usually lactose is the sugar in the glycosuria of pregnancy, but it may be grape-sugar, or both. The glycosuria of pregnancy is probably of the renal type, hence without abnormal proportion of sugar in the blood. (k) It sometimes follows *acute infectious diseases*. (l) *Locality*.—Diabetes mellitus is, comparatively speaking, rare in America, although Hare's statistics indicate that diabetes is becoming more prevalent. In certain other countries (Normandy, India, France) diabetics appear to be constantly increasing in number, the mortality in Paris having more than doubled from 1883 to 1892, inclusive. The disease is much more frequent in cities than in rural districts. (m) *Diet*.—An overabundant diet rich in carbohydrates seems to be a factor in some cases of diabetes. On the contrary, a diet such as many of the combatant countries in the Great War were compelled to resort to not only decreased the average number of new cases seen but also exhibited a beneficial effect upon the known cases of diabetes. Williamson found in his 300 cases that prolonged excessive eating of sugar or sweetened foods was a predisposing cause in 93, or 31 per cent.

¹ *Jour. Biol. Chem.*, 1916, xxvi, 417.

² *Jour. Amer. Med. Assoc.*, August 8, 1914, p. 485.

³ *Amer. Jour. Med. Sci.*, August, 1916, p. 157.

⁴ *Jour. Amer. Med. Assoc.*, 1918, lxx, 365.

Special Etiology.—Under this head may be arranged the following groups of cases: (1) *Diabetes* due to *pancreatic disease*. (2) Cases occasioned by *hepatic disease* (*organic and functional*). (3) Those comparatively rare instances caused by *disease of the brain* (*tumors, sclerosis, or irritative lesions of the diabetic center*) and *spinal cord*. (4) *Disease of the posterior lobe of the pituitary gland*. (5) *Diabetes* following *traumatism*, and especially injuries to the head. Not infrequently it occurs after injuries to other parts of the body, such as the spine, sacral region, abdomen, etc. In 212 cases of traumatism of the head Higgins and Ogden found 20 cases of glycosuria, though only a small proportion of the cases (2) exhibited a permanent glycosuria.

Clinical History.—For the sake of accuracy and convenience of description, the cases will be divided into the acute and chronic forms.

1. **ACUTE DIABETES MELLITUS.**—The instances are few and the course is, as a rule, rather subacute than acute, manifesting a predilection for the young and middle aged. The *onset* is more abrupt than in the chronic form, but the characteristic features do not differ from those of the latter. Many of the cases due to pancreatic disease are of this class. Exceptionally, acute diabetes occurs in the aged.

2. **CHRONIC DIABETES.**—The symptoms are evolved *slowly and gradually*, as a rule, and prominent among prodromal conditions is dyspepsia or chronic gastric catarrh. We may note certain nervous disorders, such as headache, mental irritability, moroseness, and insomnia, with or without gastro-intestinal symptoms. The patient may suffer merely from general debility and malaise, and either frequent micturition, polyuria, or unnatural thirst is apt to be noticed. Rarely diabetes has an *abrupt onset*, as after an injury, a sudden nervous shock, or a chill. With the development of the affection the polyuria and thirst become marked, the appetite keen, and glycosuria appears. In spite of the enormous quantities of food taken, progressive emaciation and debility attend.

Leading Symptoms and Complications in Detail.—(1) *The Urinary Symptoms.*—The daily amount of urine varies from 4 to 5 pints to as many gallons. In mild cases and in intercurrent febrile attacks it may be slightly, if at all, increased in quantity. The twenty-four-hour specimen should be examined at once, lest yeast-cells develop and cause the sugar to disappear. Its color is pale and its specific gravity ranges from 1020 to 1050, rarely being as low as 1015; it has an acid reaction, a sweetish, aromatic odor, and a distinctly sweetish taste. Sugar is present, the amount varying from $\frac{1}{2}$ to 1 per cent. in mild cases, to 5 or even 10 per cent. in severe attacks. The amount eliminated in the twenty-four hours varies from 5 ounces to 1 pound or more.

Other forms of sugar than glucose (inosite and levulose) may be contained in the urine, and glycogen has rarely been found. The urine may also contain acetone bodies (acetone, diacetic acid, beta-oxybutyric acid). Hirschfeld's studies upon the excretion of acetone in diabetics show that in severe forms an increased amount is excreted. Diacetic acid is probably of graver significance than acetone, while the presence of beta-oxybutyric acid is a danger-signal of diabetic coma (*vide infra*).

The *urea* is increased, Kaufman finding it in the blood of diabetic dogs to be doubled. *Uric acid* is either normal in quantity or increased, but a large amount of ammonium is present, indicating an increase of organic acids. The phosphates may also be present in greatly increased proportion (Ralfe), and in such cases the glycosuria may be more or less intermittent. Lipuria may be present and creatinin is increased.

Slight albuminuria, often with an intermittent tendency, is common even in the early stages, and is not of grave significance. Well-marked nephritis

with its characteristic phenomena may develop, though usually in advanced diabetes; and if albuminuria be marked, the amount of sugar excreted may be considerably diminished. The development of chronic interstitial nephritis, however, is not a favorable complication, as some have supposed. The glycosuria, or absence of glycosuria, is not a true criterion of the hyperglycemia, since the nephritis has lowered the permeability of the kidney for sugar. In these cases the estimation of the sugar of the urine should always be supplemented by the determination of the sugar of the blood (Chase and Myers).¹ Arteriosclerosis may be observed, and pyelonephritis (rarely) and cystitis (not rarely) may appear as complications. A marked reduction in the percentage of dextrose may accompany the development of intercurrent febrile affections. As the result of fermentative processes in the bladder gases may form (*pneumaturia*).

(2) *Digestive Symptoms*.—Although a general feature, *thirst* may be discussed under this head. This symptom may be most distressing, necessitating the drinking of large quantities of water at frequent intervals both by night and by day. The amount of water taken stands in direct relation to the amount eliminated. Notwithstanding the fact that the increased amount of water is needed to dissolve the sugar, cases of confirmed diabetes are met with in which thirst is not marked. Cases are also encountered in which the amount of urine is large and the percentage of sugar excreted very low. The cause of the unusual thirst is probably an increased systemic demand for liquids.

The *appetite* is abnormally large and sometimes almost insatiable (*bulimia*), and there may be an intense craving for carbohydrates. Luckhardt's studies indicate that the polyphagia is attributable to true hunger rather than to some perverted appetite due to the condition. I have, however, met with instances of diabetes in which the appetite was not inordinate. Considering the quantity of food consumed, the digestion is often surprisingly good, but the association of dyspepsia and diabetes is by no means an uncommon one. The stomach may be found enormously dilated at times, yet functioning normally. There is constipation, though brief intervening attacks of diarrhea may occur.

The *tongue* is generally dry, large, often presenting a rough and fissured surface, and it may either be coated or red and glazed. The gums sometimes swell, and may ooze blood. The saliva is scanty and its reaction persistently acid, while the salivary secretion may show sugar on testing. The teeth decay, and aphthous stomatitis or thrush may attack the oral cavity.

The *liver* is frequently somewhat enlarged, though the biliary secretion usually is not disturbed; jaundice may, however, arise as a complication. Marie has given a description of *pigmentary "hypertrophic cirrhosis with diabetes mellitus,"* of which only 9 undoubted cases have been published. It appears late in adult life, and, in addition to the symptoms of diabetes mellitus, slight ascites, considerable hypertrophy of the liver and spleen, with brown or even gray-black cutaneous pigmentation, are among the chief features noted. There is no true icterus as a rule, but the urine is highly colored and contains bile-pigments. Bernoulli² reports 41 cases of so-called bronzed diabetes.

(3) *Cutaneous Manifestations*.—Diabetic urine, on account of the sugar it contains, has irritant properties, and often produces in the female *pruritus vulvæ*, a troublesome symptom and one that should excite suspicion of this disease. In the male, *balanitis* often occurs, due to the effect of the decomposing urine, and from the same cause the genitals and adjacent cutaneous surfaces may be the seat of *eczema*, particularly in women. General *pruritus*, due to

¹ *Jour. Amer. Med. Assoc.*, September 23, 1916, p. 929.

² *Correspondenz-Blatt für Schweizer Aerzte*, Basel, July 1, 1910.

irritation of sensory nerves by the glycemia, may be observed. The skin is usually harsh and dry, though rarely copious perspiration may be observed and particularly if phthisis be a complication. The hair often falls off, and in one of my cases *onychia* with shedding of the nails occurred. Among the commonest of the early cutaneous symptoms are *furuncles* and *boils*. Later large *carbuncles* often appear. *Gangrene* (especially of the feet) due to arteriosclerosis is not infrequent, and *edema*, arising independently of nephritis, is not uncommon. Morris has reported 21 cases of *xanthoma diabeticorum*.

(4) *Nervous Symptoms*.—*Peripheral neuritis* is common. The most frequent form is *diabetes tabes*, indicated by an absence of the knee-jerks, darting pains, paresis of the extensors of the foot, and by the steppage gait. Other symptoms may be numbness, tingling, and certain trophic disturbances—shedding of the nails and perforating ulcer of the foot. R. T. Williamson found the knee-jerk absent in 25 of 50 cases recorded; and in 18 of 21 cases of diabetic coma. Schupfer attributed absence of patellar reflex to toxic effects in most cases. Neuralgia may be a troublesome symptom, particularly when it is of the symmetric sciatic type, and it points to neuritis. The same is true of paraplegia, a condition that may be met. Herpes zoster may be observed.

Psychopathia (e. g., irritability of temper, hypochondriasis) may sometimes be present, and temporary hemiplegia has been noted.

(5) *Special-sense Symptoms*.—Not infrequently cataract develops, leading to blindness. Its cause is not clear. Transient ptosis and strabismus are seen, and among other ocular conditions are optic-nerve atrophy, iritis, retinitis (often due to associated nephritis), and hemorrhage. Amaurosis is rarely observed. Krause and Heine¹ emphasize a marked reduction in the intra-ocular pressure in diabetic coma. Among the aural symptoms I would mention otalgia, otitis media, and mastoid disease.

(6) *Muscular Symptoms*.—In diabetics there is a tendency to cramps, especially in the calf of the leg, that appears during the night and on waking in the morning. Unschuld found it present in 33 out of 109 cases. Another variety of cramps that may appear at any hour of the day may occur with the so-called "gastric crisis." In these attacks colicky pain in the epigastrium with vomiting and fever attend.

(7) *Respiratory System*.—Rapid, deep respirations are one of the characteristic symptoms of acidosis, as acids act as a stimulus to the respiratory center. Serious pulmonary complications may appear in the advanced stages. The most frequent is pulmonary tuberculosis, which has the customary termination, and does not differ from the usual form of the disease. A peculiar vasomotor skin eruption (hyperemia, bright redness), with bulbous fingers, is sometimes found in cases complicated with pulmonary tuberculosis. A second, quite frequent complication is gangrene (circumscribed or general). The peculiar offensive odor of the expectoration may be wanting here. A serious form of *pneumonia* (lobar or lobular) sometimes occurs, and may terminate in gangrene.

(8) *Circulatory System*.—The *pulse* may be of natural frequency and tension. In other cases it is somewhat slow, and the tension may be increased; this is often due to an associated arteriosclerosis. The heart is sometimes quite weak. The rate of the pulse, therefore, varies greatly: it may be slow (brachycardia), not exceeding 40 or 50 beats per minute, or it may be accelerated. Dyspnea, a tendency to syncope, and gastric disturbance may be seen in combination. Associated with diabetic lipemia, fat embolism may occur. Symptomatic anemia is present, and, in most cases, a relative lymphocytosis.

¹ Quoted by Hertel, *Münch. med. Wchnschr.*, June 3, 1913.

(9) *Sexual Symptoms*.—Impotence may be an early symptom; it is often of great diagnostic significance. Diabetes may be acquired during pregnancy; *per contra*, the diabetic may conceive, though rarely, and bear a healthy child; but death of the fetus occurs in about one-half of the cases. Premature delivery occurs in many cases (26 per cent.). After delivery the condition is generally aggravated.

(10) *Constitutional Symptoms*.—Usually there is a constantly increasing loss of flesh and strength. In the mildest types, however, good bodily nutrition and a fair degree of strength may be maintained. When emaciation is progressive the polyuria is apt to be proportional. The temperature is at first normal, later usually subnormal, though intercurrent febrile attacks, due to complications, are often witnessed.

(11) *Acidosis* is a manifestation of severe diabetes and should always be carefully watched for in handling such a case. The condition is the result of "a disturbance of acid-base equilibrium" (Howland). In diabetes it is due to the faulty metabolism of fats, from lack of carbohydrate utilization, whereby an excess of fatty and other acids accumulate in the blood. Similarly, in starvation where carbohydrates are withheld the acetone bodies may accumulate in the blood. In nephritis the acidosis that occasionally is seen is presumably due to faulty excretion, incomplete excretion of these bodies, or to retention of acid phosphate. In severe burns or in cardiac dyspnea acidosis is probably the result of insufficient oxidation of the tissues, while the acidosis that arises in cholera, severe diarrhea, etc., may be due to loss of bases from the intestines. It must be understood that in acidosis free acids do not exist as such in the body, but the excess of acid uses up the alkali reserve of the tissues, causing a tissue asphyxia.

The symptoms of early or slight acidosis include headache, nausea, malaise and indefinite, vague neuralgic pains. As acidosis develops there appears one very pronounced clinical symptom, hyperpnea, or very deep, rather rapid respirations due to the stimulation of the respiratory center by the increase in acid. A fruity odor may also be noted on the breath and vague cerebral signs may be present. Laboratory methods are of the greatest value in determining the degree of acidosis. Of these, the estimation in the alveolar air of the carbon dioxide tension is possibly the most accurate and readily performed. Normally it is about 40; in diabetes it becomes less and less in direct relation to the severity of the acidosis, so that, for example, figures under 20 are indicative of approaching coma.¹ Another method is the estimation of the alkali reserve of the blood. More complicated methods include the hydrogen ion concentration of the blood-serum, the combining power of the plasma for CO₂ and the method of Sellards. A simple but not exact procedure has been recommended by Sellards, and modified somewhat by Henderson and Palmer. The reaction of the urine is tested before and after giving sodium bicarbonate by the mouth. The amount of soda necessary to neutralize the urine or make it alkaline is an indication of the amount of alkali reserve that has been used up by the acetone bodies. The estimation of the degree of acetonuria is not an indication of acidosis, as it does not show the extent of diminution of the body alkalies.

Acidosis, in spite of treatment, may terminate in coma, or the coma may appear suddenly and unexpectedly without premonitory symptoms, suggesting the presence of acidosis. Coma usually results in death. Clinically, coma may have its onset in one of the following ways:

¹ *Amer. Jour. Med. Sci.*, 1916, cli, 184. In this article Peabody gives a splendid summary of the subject of acidosis, more particularly in its relation to respiration. For further and more detailed information concerning acidosis consult various papers by Howland and Marriott, Henderson, Austin, Peabody, Van Slyke, Sellards, and Stillman.

Group 1.—To this belong abortive forms that terminate in quick recovery. This process may be repeated several times at intervals, and at last a fatal coma may supervene.

Group 2.—Perhaps the largest, in which the diabetic coma follows some form of exhausting exercise. It may end fatally in a few hours or, though less frequently, in three or four days.

Group 3.—This is a comparatively small class, and is characterized by collapse of circulation (small, rapid, feeble, pulse cyanosis, etc.), leading to coma. It is induced either by overexercise or by alcoholic intoxication. I have seen 2 typical instances. Ehrmann calls attention anew to a characteristic drop in the blood-pressure preceding diabetic coma due to the toxic action on the cardiovascular system of the acetone bodies.

Group 4.—Without previous dyspnea or distress there appear such symptoms as headache and signs of intoxication, and these are followed quickly by deep and fatal coma (Frerichs).

Group 5.—Here diabetic coma is preluded by symptoms of some localized disorder, such as gastro-enteritis, pharyngitis, pneumonia, gangrene, or carbuncle. The attack sets in with headache, delirium, distress, and dyspnea, both inspiratory and expiratory. Cyanosis may develop early, and, if so, cardiac failure precedes the coma. The duration is from one to five days. This group, which was first described by Frerichs, may have a different onset, and I have seen 2 fatal cases, one attended by carbuncle and the other with gastric symptoms.

Group 6.—Hirschfeld has recently described a class of cases in which we find, in old persons, a moderate glycosuria and coma supervening under the influence of gangrene or carbuncle.

Prognosis.—In acute diabetes the *duration* varies from a few days to eight or ten weeks, while in chronic diabetes the course ranges from one or two to five or even ten years. When the disease commences in the declining period of life, the course is longer still. The severe forms are generally fatal, and occur, as a rule, at an early period of life and in persons with an hereditary taint. The mild types and those that occur later in life offer a more hopeful prognosis, and in certain cases the withdrawal of all carbohydrates from the diet will cause the sugar to disappear from the urine. Of the special varieties, *alimentary glycosuria* is altogether favorable in its course, *traumatic diabetes* somewhat less so, while the prognosis of the *pancreatic form* is quite unfavorable.

Stout persons bear saccharine diabetes better than lean. Joslin¹ in a series of 1187 cases found 62 who lived longer than fifteen years; 60 of these patients were obese. Diabetes in gouty subjects often pursues a favorable course. Pre-existing affections may render the prospect gloomy, and certain complications indicate grave danger (coma, phthisis, gangrene, pneumonia, cardiac weakness, nephritis). Of 108 such cases, 64 per cent. terminated fatally (Wegeli), and between the ages of four and five years 20 out of 29 cases perished. The appearance of beta-oxybutyric and diacetic acids in the urine is of serious omen, although better borne by young than old subjects on account of better kidney function in the former. Joslin² has noted the causes of death of diabetic patients in 420 cases. Of these, 17 died of carcinoma, 16 of pulmonary tuberculosis, 62 of cardiorenal and vascular changes, 36 of acute infections (local and general), while coma caused death in 273, or two-thirds of the total number. Certain writers contend that all diabetic children die of coma. Cases showing heredity give an increased mortality rate.

¹ *Amer. Jour. Med. Sci.*, 1918, clv, 47.

² *Ibid.*, March, 1916, p. 313.

Diagnosis.—Diabetes is distinguishable by means of (1) its influences and its pathologic antecedents and relations; (2) its gradualness by certain suspicious symptoms (*e. g.*, debility, impotence, symmetric sciatic cataract, furunculosis); (3) the persistent presence of glycosuria, polyuria later, acetonuria and albuminuria; (4) the inordinate thirst and appetite; (5) cutaneous boils, carbuncles, gangrene, pruritus vulvæ, balanitis; (6) neuropathies (especially double sciatica), diabetic tabes, and coma; (7) muscular cramps; (8) special complications; and (9) the long course with slowly progressive asthenia and wasting.

In suspicious cases, even before the discovery of sugar in the urine, sugar may be administered for diagnostic purposes. If glycosuria or the blood-sugar is higher than normal, and persists so for more than 24 hours, a lessened tolerance to carbohydrates is shown. This does not necessarily imply diabetes. Janney and Isaacson¹ recommend as a test of tolerance the giving of a weighed amount of glucose equivalent to 1.75 g. of sugar to every kilogram of body weight. The blood-sugar is estimated by injection of the glucose, one and two hours afterward. The work was done independently, but about the same time as that of Hamman and Hirsch (vide p. 405). The results of the independent investigators are practically the same. Williams² holds that these tests are of great value not only in differentiating cases of mild diabetes but also in determining the degree of failure of carbohydrate metabolism in severe cases.

Treatment.—1. A properly regulated diet is of the first importance. Such food articles as contain starch or sugar (honey, sugar, ordinary bread, biscuits, rusks, toast, arrow-root, oatmeal, cracked wheat, potatoes, tapioca, sago, peas, beans, turnips, carrots, parsnips, asparagus, artichokes, squashes, beets, corn, rice, hominy, the stalks and white parts of cereals, figs, grapes, prunes, apples, pears, bananas, jams, syrups, sweet pickles, chocolate, cocoa, liquors, and sweet wines) are either to be prohibited or restricted to definite quantities, as will be pointed out below. Among articles to be forbidden are also the livers of animals, mollusks (oysters, etc.), and the meat of crabs and lobsters. The chief diet must be nitrogenous, and my plan is to first note the effect of a rigid dietary, as follows:

(a) *Animal food:* Fresh meats, poultry, game, bacon, ham, fish of all kinds, including crabs and lobsters (except the inside meat of the latter). Fatty substances should be restricted on account of the danger of producing an acidosis. Eggs, cream-cheese, curds, and buttermilk are also allowed.

(b) *Vegetables:* Sauer-kraut, lettuce, sorrel, mushrooms, water-cress, spinach, chicory, celery, cucumbers, mustard-cress, and pickles of various sorts (except sweet).

(c) *Bread:* The crust of a French roll, first recommended by Flint. Ellis has recently very highly recommended aleuronat bread; it contains a small proportion of vegetable albumins. The so-called No. 1 gluten biscuit is the only form of gluten bread made in this country that does not contain more than as much starch as the white flours (Tyson).

(d) *Fruits:* Lemons, oranges, and nuts (except chestnuts).

(e) *Beverages:* Milk enough for cooking purposes; tea and coffee, sweetened with glycerin or saccharin; alkaline mineral waters (Saratoga-Vichy, Seignette water), simple water with some brandy, and acidulated drinks; Bass's ale, in which all the sugar is converted into carbonic acid and alcohol, and certain acid wines (claret, Rhine).

This strict diet usually causes the sugar to diminish greatly in amount and in many cases to disappear entirely. If the patient keeps well nourished

¹ *Jour. Amer. Med. Assoc.*, 1918, lxx, 1131.

² *Arch. Int. Med.*, 1919, xxiii, 559.

and strong, carbohydrates need not be added. The effects upon the general condition of the patient (body weight), as well as upon the glycosuria (ascertained by a daily quantitative estimation of the sugar in the urine) and the glycemia, are to be carefully noted, and the proportion of carbohydrates may be increased gradually until the limit of the system's ability to assimilate them is found. A more generous dietary is allowable only after the sugar has been absent from the urine for a couple of months, and then it is to be adopted in a gradual manner. Failure to make the urine sugar free by the ordinary methods of restricting carbohydrates, or threatening coma, are indications for the so-called starvation treatment.

This dietetic method of treatment, first recommended by Allen, is now generally accepted and the main elements are as follows: The patient is made to fast until his urine is sugar free and then for twenty-four hours longer. The duration is usually three to ten days. One cup of tea or one of coffee daily is allowed. During this time the patient may drink water freely and is encouraged to be up and about, and to exercise as much as possible. If acidosis (diabetic acid) is present, 0.5 c.c. of alcohol per kilogram of body weight daily should be administered until acidosis disappears. It is best given in small doses every three hours. At the end of the fast feeding is begun with vegetables containing 5 to 6 per cent. carbohydrates, 200 grams being given the first day. Joslin¹ has arranged vegetables, fruits, and nuts according to the percentage of carbohydrates, as per the following diet chart, which may be followed conveniently:

VEGETABLES:

5 Per Cent.		10 Per Cent.	15 Per Cent.	20 Per Cent.
Lettuce.	Cauliflower.	Onions.	Green peas.	Potatoes.
Spinach.	Tomatoes.	Squash.	Artichokes.	Shell beans.
Sauer-kraut.	Rhubarb.	Turnips.	Parsnips.	Baked beans.
String beans.	Eggplant.	Carrots.	Canned lima	Green corn.
Celery.	Leeks.	Okra.	beans.	Boiled rice.
Asparagus.	Beet greens.	Mushrooms.		Boiled macaroni.
Cucumbers.	Water-cress.	Beets.		
Brussels	Cabbage.			
sprouts.	Radishes.			
Sorrel.	Pumpkin.			
Endive.	Kohl-rabi.			
Dandelion.	Broccoli.			
Swiss chard.	Vegetable			
Sea kale.	marrow.			

FRUITS:

Ripe olives (20 per cent. fat).	Lemons.	Apples.	Plums.
Grape-fruit.	Oranges.	Pears.	Bananas.
	Cranberries.	Apricots.	
	Strawberries.	Blueberries.	
	Blackberries.	Cherries.	
	Gooseberries.	Currants.	
	Peaches.	Raspberries.	
	Pineapple.	Huckleberries.	
	Watermelon.		

NUTS:

Butternuts.	Brazil nuts.	Almonds.	Peanuts.
Pignolias.	Black walnuts.	Walnuts	
	Hickory.	(English).	40 Per Cent.
	Pecans.	Beechnuts.	Chestnuts.
	Filberts.	Pistachios.	
		Pinenuts.	

¹ *Amer. Jour. Med. Sci.*, October, 1915, 485.

Should sugar appear, another fast day is inserted, and the same vegetables given, but cooked in three different waters. These are practically carbohydrate free and always tolerated. In either case, the amount given is doubled daily until a fair tolerance is obtained. Each appearance of sugar is the sign for an extra fast day.

Whenever the tolerance is less than 20 grams carbohydrate, fasting should be practised one day in seven; when the tolerance is between 20 and 50 grams carbohydrate, 5 per cent. vegetables and one-half the usual quantity of protein and fat are allowed upon the fast day; when the tolerance is between 50 and 100 grams carbohydrate, the 10 and 15 per cent. vegetables are added as well. If the tolerance is more than 100 grams carbohydrate upon the weekly fast day the carbohydrate should be halved.

Feeding is subsequently begun with not more than one-half of the carbohydrate contained in the diet at the time of the appearance of glycosuria. Subsequent carbohydrate increase is made very gradually. When vegetable tolerance is ample, meat and eggs are added. Fats are added last. A somewhat more exact method of controlling the condition is by observing the percentage of blood-sugar rather than the glycosuria. Yet even this method may not be satisfactorily carried out, as there is apparently in diabetes an attempt of the organism so to adjust the carbohydrate metabolism that sugar may be more completely utilized by increasing the fasting blood-sugar percentage. Therefore the attempt to reduce the blood-sugar to normal values may do harm to the diabetic (Mosenthal, Clausen, and Hiller¹).

Exercise is a valuable addition to the Allen method of treatment, since it has been found that in a patient free from glycosuria with persistent hyperglycemia one fast day with exercise may reduce the blood-sugar as much as several fast days without exercise.

In severe, long-standing cases in which fat metabolism has suffered greatly it has been suggested that the fats first be withdrawn from the diet, then proteins, and lastly carbohydrates. By this method the dangers of acidosis are minimized to even a greater extent than by the immediate withdrawal of all food.

2. Next to an appropriate diet stand certain directions as to proper hygienic living: (a) All forms of mental excitement and worry must be avoided; (b) moderate and regular physical exercise aids metabolism, and is thus directly useful; massage may be substituted for active exercise when the latter is prohibited on account of weakness; (c) the diabetic requires a temperate and equable climate; (d) a daily tepid bath if the patient be feeble, and a cold bath if he be strong, are to be commended; (e) flannels should be worn next to the skin all the year round; (f) the living and sleeping apartments must be thoroughly ventilated; (g) the teeth must receive careful attention in order to prevent caries.

3. **Symptomatic Treatment.**—Stillman² describes the routine treatment of severe acidosis as carried out at the Rockefeller Institute Hospital as follows: Sodium bicarbonate, 3 gm. per hour, dissolved in cold water until the plasma bicarbonate becomes normal; fluids forced to the limit, up to 5000 c.c. in twenty-four hours; clear strong coffee up to 1000 c.c. a day; active catharsis with calomel and salts, together with colonic irrigations; fasting from six to twelve hours; if plasma bicarbonate is not increased, light feeding of proteins, 600 to 800 calories. Alcohol has been shown to have no beneficial effect on acidosis and is, therefore, not recommended. In general it may be said that fasting not only clears up an acidosis but also rids the urine of sugar. In a small per-

¹ *Arch. Int. Med.*, 1918, xxi, 93.

² *Ibid.*, 1919, xxiv, 445.

centage of cases (6.4) Stillman found that fasting either developed or augmented a severe acidosis. It is in such cases that the above routine is practised. Where it is impossible to have the patient in a hospital or under laboratory control the ferric chlorid reaction gives a simple and fairly accurate clinical method of determining the degree of acidosis. The appearance of a heavy reaction is a definite indication to discontinue fasting and to start active treatment to ward off the threatened coma. Furthermore, the failure of the iron reaction to disappear after several days of fasting should also be considered an indication to stop the fasting treatment if the blood bicarbonate has not been observed daily.

If a patient is seen first in a state of diabetic coma, bicarbonate of soda should be given intravenously in a 6 per cent. solution; 500 c.c. should be given, and the infusion repeated in six hours, and again six hours later. Boiling changes the alkaline bicarbonate to the carbonate, so the solution should not be prepared by boiling the liquid with the chemical. The chemical should be sterilized by dry heat and then added to sterile water which is brought to body heat. In an emergency when it is impossible to get sterilized bicarbonate of soda the pure crystals may be put directly into the water. This is a measure, however, that should be employed only in emergency. The crystals are sterile when prepared, but of course subsequently become more or less contaminated.

The subsequent treatment of a case of severe acidosis after the critical symptoms have been relieved is to determine the carbohydrate tolerance and then, later, the maintenance diet.

DIABETES INSIPIDUS

Definition.—A chronic affection, characterized by constant thirst and an excessive flow of urine, which is free from sugar and of low specific gravity.

Pathology.—Some degree of enlargement of the kidneys, together with sacculation, due to pressure backward upon the renal structure by the enormous quantities of urine in the bladder and ureters, has been observed. The ureters and pelves of the kidneys may be dilated, and the bladder, owing to constant overdistention, may be hypertrophied. The most important pathologic finding is some irritative lesion of the pituitary gland, which is, however, not always seen.

Etiology.—(a) Diabetes insipidus is often induced by injuries to the head or may possibly follow shock or fright. (b) It may occur during convalescence from *acute infectious diseases*. I have seen two instances after influenza in young subjects. (c) *Intemperance*, especially the consumption of inordinate quantities of malt liquors, proves a cause. (d) *Heredity*.—Weil found in four generations of a certain family, consisting of 91 members, that 23 exhibited continuous polyuria—all, however, remaining in good health. (e) *Age*.—The disease is relatively more frequent in childhood and early adolescence than is diabetes mellitus. Of 70 cases collected, 22 were under ten years of age, and 13 between ten and twenty (Roberts). (f) Most cases occur in males as compared with females. (g) Syphilis, either acquired or inherited, may cause it.

Pathogenesis.—There is a growing tendency to consider diabetes insipidus an evidence of disturbance in function of the pituitary gland. Meyer, Frank, Simmonds, Cushing, and others have demonstrated the frequency with which polyuria is associated with pituitary disease. Motzveldt¹ advances the theory

¹ *Jour. Exper. Med.*, 1917, xxv, 153.

that the pituitary glandular secretion has a definite antidiuretic effect, particularly when diuresis is high. He has already shown that extracts of the posterior lobe of the pituitary have a distinctly beneficial effect in the treatment of the disease. Now he shows experimentally that such extracts are able to check an induced polyuria, independent of the blood-pressure, intestinal absorption, or the vagus nerves.

Clinical Symptoms.—The *onset* is *gradual*, as a rule, but when it follows traumatism it may develop quickly. There are two main symptoms—the passage of an enormous quantity of limpid urine and the constant thirst. The daily *amount* of urine varies from 20 to 60 pints (10–30 liters); it is transparent, and the specific gravity is low (1001 to 1005). While the percentage of solids is lessened, the total is usually about normal, and may even be increased. *Albumin* and *sugar* are rare. The act of micturition is of very frequent occurrence, and the quantity of urine passed at each sitting surprisingly large. The persistent *thirst* necessitates frequent drinking, but the voracious appetite seen in diabetes mellitus does not mark this disease, in which the appetite is only slightly increased. As a result of the polyuria the skin and mucous membranes are abnormally dry, as in genuine diabetes. But, unlike the latter affection, a fair degree of bodily nutrition is maintained as a rule. The saliva and other digestive secretions are scanty, and this, together with the good appetite, is a fact which explains the disturbances of digestion sometimes met with. The tolerance of the system to alcohol is often phenomenal. Nervous phenomena are frequently observed, such as neurasthenic symptoms, insomnia, and choreiform movements.

Prognosis.—The majority of instances proceed to recovery sooner or later, while others pursue an almost endless course—forty or even fifty years in duration—and the patient meanwhile retains his general good health. Cases due to pituitary tumors may live only a comparatively short time after the appearance of the symptoms. Death may also be occasioned by some intercurrent affection.

Diagnosis.—The clinical recognition of diabetes insipidus rests upon: (a) the enormous amount of urine passed; (b) its low specific gravity, and (c) the absence of sugar and albumin.

Differential Diagnosis.—Among affections that must be differentiated are *diabetes mellitus*, which has a single point of resemblance, namely, the polyuria; *hysteric polyuria*, which is transient and accompanied by other hysteric manifestations; and *chronic interstitial nephritis*, which generally distinguishes itself by the presence of albumin and hyaline casts in the urine, arteriosclerosis, and cardiac hypertrophy.

Treatment.—The amount of drinking-water is to be moderated in a gradual, cautious manner, and the patient should be warned not to exceed his actual necessities. I find also that methodic physical exercise and a diet poor in salt reduces the diuresis. Galvanism has its advocates.

Treatment based upon the etiology, the deficiency of pituitary secretion, has in recent years been largely the administration of pituitary extracts by hypodermic or by mouth. Excellent results have been attributed to this form of therapy. The drug must be frequently repeated, as its effect is transitory. Other drugs that have been employed include the valerianates, the bromids, the coal-tar preparations, potassii iodid, quinin, ergot, gallic acid, arsenic, strychnin, and opium. This long list of drugs that have been advocated is sufficient commentary of their usefulness. In one case Herrick obtained excellent results from lumbar puncture. If a primary disease—*e. g.*, syphilis—exists, it must be met on intelligent general therapeutic principles.

ARTHRITIS DEFORMANS

(Rheumatoid Arthritis; Rheumatic Gout)

Definition.—A chronic disease, characterized by progressive changes in the arthritic structures (cartilages, synovial membranes, etc.) and by osseous periarticular formations, producing great deformity. The affection may rarely be acute in its course.

Pathology.—An atrophic and a hypertrophic form are recognized. Among early gross changes in the atrophic form may be an effusion into the affected joints, but this disappears later. The cartilages are absorbed, the process beginning centrally, where there are both the maximum amount of friction between the opposed cartilaginous surfaces and the minimum blood-supply. Disappearance of the cartilages is followed by the formation of new bone or fibrous tissue. Ankylosis may occur, and in marked cases two bones may have a common marrow cavity.

The hypertrophic form (degenerative arthritis deformans—osteoarthritis) is characterized primarily by changes in the cartilage, secondarily by bony changes in the joint. There is around the joint a series of long nodular outgrowths which interfere seriously with the motion of the joint. Upon opening such a joint there is found no new fibrous tissue nor tendency to ankylosis. The cartilage may be eroded away and the opposing bones may become eburnated.

Etiology.—There are three chief theories advanced to explain the etiology of the condition: (1) That it is nervous in origin; (2) that it is a manifestation of abnormal metabolic processes, and (3) that it is the result of some chronic infectious process. The first two views have been very generally discarded and the weight of present-day opinion seems to be that the disease results from the absorption from some focus of infection of toxins which have a special predilection for joint tissues, or from the direct action of bacteria which have selective affinity for these tissues. Billings, among others, insists that arthritis deformans is an infectious entity. Among foci of infection, peridental infection is common. Other local infections that may be followed by arthritis deformans are tonsillitis, sinusitis, pelvic disease in women, and prostatic or seminal vesical disease in men; chronic gall-bladder disease, chronic appendicitis, or possibly the intestines, as in a chronic colitis.

Bacteriology.—Dor claims to have succeeded in finding a definite organism. He also claims to have reproduced the disease by injecting cultures directly into the blood of rabbits, and considers the germ an "attenuated culture" of the *Staphylococcus pyogenes aureus*. v. Dungern and Schneider isolated after death from the mucus of the gall-bladder, and also from the exudate in the joints, small diplococci that did not resemble the organisms previously described by Blaxall and Schüller. Injections of the cultures in the knee-joint of rabbits resulted in lesions similar to those observed in the patient. E. C. Rosenow contends that the disease is caused by *streptococci*. He has shown that streptococci vary greatly in cultural and biologic characteristics, and has been able, by special anaërobic cultures, to isolate streptococci from affected joints which reproduced the disease in laboratory animals.

Predisposing Causes.—(a) *Females* are more frequently victims than are males, the proportion, according to the statistics of Garrod, being about 1 to 5 in favor of the former sex. (b) *Age* exerts a decided influence. It is most frequently contracted in the third decade of life, though it has been noted as late as the end of the fifth. It occurs also in children, though rarely. Out of 307 cases treated in the Devonshire Hospital during 1892, only 2 per cent. manifested the disease before the age of ten. (c) *Heredity* has been traced in

of Marie, or the condition may be confined to the cervical spine, as in a recent case of my own, thus preventing flexion of the head. A fair degree of rostatic usually remains, but it sometimes happens that the entire spinal column is involved and held in a perfectly rigid position.

Still another form in which the distal joints of the fingers become knobby (*Heberden's nodes*) demands separate description. Heberden's nodosities occur chiefly in women between the thirtieth and fortieth years. According to Heberden, who first described them, the nodes have no intimate association with gout, and this view coincides with my observations. At first the affected joints become swollen, tender, slightly red, and painful, and then seemingly undergo great improvement. The condition, however, is progressive, advancement occurring in the form of fresh exacerbations, which are only rarely traceable to errors in diet, and are separated by periods of remission. The morbid process is an osteoarthritis, and the destructive changes in the joints proceed until distinct hard nodules are formed. These are usually most marked at the sides of the extensor surfaces of the second phalanges. The disease does not spread to any of the larger joints, and, although incurable, it is free from danger to life.

(2) **The Acute Atrophic Form.**—This is comparatively rare, and occurs commonly between the ages of twenty and thirty. It occurs in children, and is more common in women than in men. Among its common antecedents in women are pregnancy, delivery, excessive lactation, and the menopause. *Multiple arthritis*, affecting both the large and small joints, sets in acutely, and there is pain and either a slight redness or a considerable swelling, due chiefly to an effusion which is intra- rather than periarticular. There is only a slight tendency to migration from joint to joint and a slight febrile disturbance.

Still described a form of chronic joint disease in children which he thinks presents differences sufficiently marked to suggest a distinct clinical and pathologic entity, and differing from arthritis of adults. It is defined as a progressive enlargement of the joints associated with general enlargement of the glands and enlargement of the spleen. He has studied 22 cases, 19 of which came under his personal observation. It occurs before the second dentition. Stiffness, general thickening of the tissues around the joints without redness or tenderness, except in very acute cases, with limitation of movement and more or less rigid flexion of the joints, characterize the arthritic disturbance. The most distinct feature of the disease is the enlargement of the lymphatic glands, those in relation to the involved joint being primarily affected. The glandular swelling is general and constant and, with the enlargement of the spleen, points toward an infectious origin. Cardiac complications are absent. The course of the disease is slow.

Differential Diagnosis.—A *monarticular arthritis* which differs in its morbid process from arthritis deformans sometimes affects the shoulder-joint. It is not uncommon, and is "characterized by pain, thickening of the capsule and of the ligaments, wasting of the shoulder-girdle muscles, and sometimes by neuritis" (Osler). I have met with 5 instances of this sort, in all of which pain was intense and the course subacute. All ended in recovery.

The frequency of the occurrence of intercurrent acute polyarthritis in arthritis deformans causes the danger of mistaking this for acute rheumatism (Thos. McCrae). Acute arthritis deformans is to be discriminated by the special etiologic factors, the less severe pain, the less marked redness, the slight tendency to migration from joint to joint, the slighter febrile disturbance, and by the practical freedom from cardiac complications. *Gout* will be distinguished in the description of that disease (*vide* p. 427).

Prognosis.—Though incurable, arthritis deformans is not immediately dangerous to life; in some cases improvement, and in a smaller proportion arrested progress of the disease, may be expected.

The treatment comprises the removal of the cause or focus of infection (see Focal Infection, page 170) and measures directed toward the improvement of bodily nutrition—a generous dietary, systematic warm bathing, and an abundance of fresh air, with properly regulated physical exercise. Tonics may be necessary to invigorate the economy, and iron to overcome the anemia. The prolonged use of cod-liver oil has given me excellent results. Of special agents, the most satisfactory in their effects if administered early are iodine and arsenic. The former may be administered in the form of a saturated solution of sodium iodide, of which 10 to 15 drops may be given in milk one hour after food. The prolonged use of extract of thyroid in small doses (gr. ss to j—0.032–0.065), with occasional intermissions, is favored where insufficiency of thyroid secretion is suspected. Good results have been noted in cases after the administration of thymus extract in small doses, the nucleoprotein extract being preferable to the crude gland. Schüller and Hirschberg have had favorable results in the treatment of this disease by limiting the amount of lime in the diet. The patient may be sent to a warm climate in winter and to a cooler one, preferably a mountain resort, in summer. These patients also do well at certain mineral springs, such as the Sulphur Springs of Virginia, the hot springs of Arkansas or Töplitz, at Baden in Switzerland, and the warm sodium chloride baths in Wiesbaden. Hot mineral spas should only be resorted to in the early period of the affection. Strümpell has seen excellent results follow the employment of hot sand-baths, which can be used at home. Stewart advocates the Tallerman method of treatment—*i. e.*, of superheated dry air. Pain may also be relieved by acetylsalicylic acid. Upon the basis that a septic focus in the seminal vesicles produces the disease, Fuller¹ has performed seminal vesiculotomy 346 times with good results. F. Billings recommends the use of autogenous vaccines. Vaccine therapy has proved of assistance in the treatment of the toxemia of long-standing cases, for it is only “in the early cases that removal of the source of infection will at once cure the condition” (Rowlands²). Thomas, in recommending the so-called *protein shock reaction*, advises a vaccine of 50,000,000 typhoid bacilli intravenously, and in those cases which have only a resulting moderate rise in temperature, an increase at intervals of two or three days to 75,000,000. A good reaction following the injection of a protein affords early relief of pain, and, according to Miller and Lusk, satisfactory end-results. Of 24 cases treated with radium, reported by seven observers, 16 showed improvement. Pemberton has achieved good results by diet controlled by metabolic studies.

The *local means* are of value. If the joints be inflamed, cold compresses, covered with oiled silk, to which some narcotic agent may be added, will afford relief. This should be followed by thorough and systematic massage, which is our best measure for the reduction of the swelling (by promoting absorption) and for lessening joint rigidity, and restoring the atrophied muscles. Says Midelton³: “The whole system improves when continuous counterirritation is properly carried out for a sufficient period in rheumatoid arthritis.” Swedish movements are useful in maintaining mobility, and mechanical or electric vibration may prove helpful. Bier’s hyperemia may be used where the affected joints are few. Immobile contractures may be broken up under anesthesia and tendons lengthened by tendoplasty, followed by plaster-of-Paris dressing until pain and irritation have subsided (Ochsner).

¹ *Med. Record*, New York, October, 1913, No. 16.

² *The Lancet*, London, January 15, 1916.

³ *The Practitioner*, London, October, 1916, p. 371.

GOUT

(Podagra)

Definition.—A disorder due to a disturbance of the purin metabolism, accompanied by the formation of an increased amount of uric acid, or associated with a diminished elimination, and characterized clinically by attacks of acute arthritis, with or without uratic deposits in and around the joints.

Nature of the Affection.—There are a number of *uric-acid theories*, some of which may be briefly mentioned: 1. Garrod contends that an acute attack of gout is invariably produced by an excess of uric acid in the blood, due to increased formation and greatly decreased elimination; also, that inflammation is caused by the deposition in the joints of sodium urate. 2. Haig holds that there is a diminished alkalinity of the blood, and that the latter cannot therefore hold the uric acid in solution and not an excessive production of uric acid. 3. Ebstein thinks it probable that there exist an excessive production and accumulation in the blood of uric acid. The surcharged blood excites local inflammation, followed by necrosis, and uric acid deposits. 4. Sir William Roberts believes that acute attacks of gout are dependent upon the precipitation of the crystalline biurate of sodium; that the urate is transformed into the less soluble biurate in the blood. 5. v. Noorden concludes that the essential process is a tissue-necrosis attributable to the presence of a hypothetic ferment, and that the uric acid, which is without etiologic effect, is deposited at the necrotic focus. Hall affirms that as an etiologic entity uric acid must be definitely discarded. 6. Klemperer has shown as the result of observations made in cases of gout that as long as the function of the kidneys is not materially interfered with the presence of considerable amounts of uric acid in the blood must be attributed to increased formation. But the presence of an equivalent of uric acid in the blood in certain affections other than gout (*e. g.*, leukemia) shows that this factor is not the sole cause of gout. 7. Morhorst states that in any alkaline liquid the basic substances combine with uric acid, if this be present, to form a urate. The uratic precipitations are met in non-vascular tissues only the alkalinity of which is less than that of the blood, and that they are the essential cause of the symptoms. 8. Kolisch maintains that when the kidneys are healthy the alloxuric bodies are, in great part, excreted as uric acid; but when they are diseased the xanthin bases are increased at the expense of the uric acid. Chittenden and others, however, hold that the xanthin bases are practically free from toxic effects. 9. Luff thinks that uric acid is formed in the kidneys from a combination of urea and glycocin, an increased amount of the latter substance being formed in the liver. 10. Duckworth insists that gout is essentially of nervous origin.

Largely as a result of the discovery by Folin and Denis of a microchemical method of estimating the amount of uric acid in the blood, much information has been gained as to the nature of gout. It has been shown that the blood of gouty individuals contains two to four times as much uric acid as does the blood of healthy persons. The uric acid output after a purin-rich diet is delayed and decreased in amount as compared to the normal excretion, while on a purin-free diet the output is normal or less than normal. Following an acute attack of gout sodium urate is deposited in the affected parts.

Pathology.—The postmortem history of gout is concerned principally with the arthritic changes, including the deposits of the urate of sodium in the cartilages, the ligaments, and the synovial membranes. These are fluid in their earliest state and contain numerous small crystalline masses; they soon inspissate and later become hard and dry (tophi). The latter excite secondary

inflammatory changes that may lead to fibrous overgrowths, distortion, and fixation of the joints. Gouty tophi may be absorbed or they may finally be discharged through the skin in consequence of an ulcerative process. The chalky concretions have been found also in the cartilages of the ears, less frequently of the nose, eyelids, and larynx. They have also been described in the periosteum and along the tendons of the palms of the hands, where they produce a characteristic form of contraction of one or more fingers (Dupuytren's contraction). Charcot has found them in the penis. If death occur in the *acute* attack, hyperemia and swelling of the capsule, ligaments, and synovial membrane are found, together with an inflammatory exudation into the joint.

The *kidneys* are usually involved, the changes being similar in character to those observed in the joints, and innumerable areas of necrosis, followed by uratic deposits, are seen throughout the organs, though chiefly in the papillæ. Osler says that "the presence of these uratic concretions at the apices of the pyramids is not a positive indication of gout." N. S. Davis, Jr., points out that the kidneys are affected in spots, with intermissions in the degenerative changes, which are microscopic in size, until finally large areas are involved. Granular contracted kidney (chronic interstitial nephritis), with or without arteriosclerosis, is sometimes caused by the gouty condition (*vide* Interstitial Nephritis).

The *heart* and *blood-vessels* always present changes. Gout induces arteriosclerosis, and the latter, in turn, causes cardiac hypertrophy, particularly of the left ventricle. In chronic cases fatty degeneration of the heart muscle sometimes occurs, and chronic valvulitis, with deposits of urate of sodium in the valves, has been noted. Chronic bronchitis, asthma, and emphysema are among the more common changes connected with the *respiratory tract*, acute conditions being rare.

Etiology.—The following are the principal contributing causes:

(a) *Heredity.*—Garrod's dictum, "that more than one-half of all gouty subjects can distinctly trace their ailment to an hereditary taint," is doubtless correct, heredity from the grandparents, which is of not infrequent occurrence, being included in this estimate. If the better class of society alone be considered, the percentage will probably be still larger. It must not be forgotten, however, that patients out of pride represent other articular affections as gout.

(b) *Age.*—Primary attacks are most frequent in middle life. They are rare before puberty, though exceptionally seen even in suckling infants; but after the age of puberty they become more frequent. After the fiftieth year they decrease rapidly in frequency, and are very rare in quite advanced life. The cases that develop quite early in life often show a striking hereditary taint.

(c) *Sex.*—The arthritic form is less frequent in women than in men, while the former are disposed to the irregular type of chronic gout quite as strongly as the latter.

(d) *Diet.*—Overindulgence in the pleasures of the table, together with defective muscular exercise, constitutes a potent factor, and this even in persons who are endowed with exceptional powers of digestion.

(e) *Alcohol*, and particularly the fermented liquors, are among the chief favoring influences. The fact explains the relatively greater frequency of gout in certain countries (e. g., England and Germany), in which the heavier beers and ales are freely used, than in America, where lighter fermented drinks are more popular. The cases, however, are on the increase in this country.

(f) *Social State.*—Most cases occur among the upper class of society, but there is also a well-defined form of "poor-man's gout" due to an excessive use of malt beverages.

(g) *Lead.*—Workers in lead furnish numerous typical examples of gout. Garrod found that in 30 per cent. of the hospital cases the patients had been painters or workers in lead. He also showed that the administration of lead salts to

gouty persons almost invariably determined a gouty paroxysm. Whether lead produces gout by arresting the excretory processes, and thus inducing a fibroid change in the kidney and liver, as is held by Oliver of New Castle, is not definitely settled. Poore points out that gout produced by lead or chronic kidney trouble is constantly associated with anemia and emaciation, and forms a distinct clinical entity. We may presume the existence of a primary renal gout. (h) Cornillon and others detail cases in which injuries were followed by the first appearance of the disease.

Clinical History.—1. **Acute Gout.**—The earliest manifestations of the disease are apt to take the form of a more or less typical attack of *acute arthritic gout*. The latter is usually preceded by certain *prodromal symptoms*, which vary in different cases, but are almost constantly similar for the paroxysms of individual cases. The patient may complain either of slight muscular cramps and articular pains, or of dyspeptic disorder, or of an asthmatic seizure; or he may exhibit mental disturbance—irritability of disposition, broken, restless sleep, and depression of spirits. In a small percentage of instances just prior to the attack the patient feels better than ordinarily. It has been observed that immediately before and also during the early part of a paroxysm the daily amount of uric and phosphoric acids found in the urine is diminished; but Klemperer has shown that no relation exists between the amount of uric acid present in the urine and the character of the disease.

The *attack* generally develops in the very early morning hours. The patient awakens suffering from pains in the metatarsophalangeal joint of the great toe that soon become excruciating, while the joint feels as if it were tightly compressed in a vise. The *local signs* of inflammation—heat, redness, swelling, and excessive sensitiveness—quickly supervene. The skin pits on pressure and becomes shiny. The *body temperature* rises to 102° or 103° F. (38.8°–39.4° C.) and the patient manifests intense irritability.

At the end of an hour or two the sufferings abate, the fever often declines, with free perspiration, and the patient may be able to pursue his avocation. During the next day some degree of enlargement and inflammatory edema remains, and on the following night the symptoms are usually repeated in all their violence. The condition usually progresses in this manner from four to seven or eight days, though after a few days the intensity of the paroxysms is apt to lessen. After the attack the swelling subsides and there is a slight desquamation of the skin, which resumes its normal color, and the general health is often unusually good. These so-called fits of gout usually recur from time to time, the duration of the intervals depending largely upon the patient's habits or routine of life. On the whole, the first interval is apt to be the longest, while later the intermissions may not exceed two or three months. With subsequent attacks the affection is apt to spread to other articulations. There is no tendency to suppuration.

2. **Retrocedent Gout.**—This term has been used to imply the sudden transmission of the arthritic process to some internal organ. In view of the wide-spread arterial sclerosis that is found in gout and the fact that the pathology of the disease cannot explain in any possible manner the transmission of the inflammatory process to one of the internal organs, it seems best to attribute such attacks to vascular spasm. In some cases, associated with nervous phenomena, it is probable that the symptoms are a manifestation of uremia.

3. **Symptoms of Chronic Gout.**—Chronic gout follows the acute variety. The transition is gradual, the intervals between attacks shorter, while the attacks themselves grow milder and longer. At last the local inflammation does not appear. The condition extends to other joints: first, to the corres-

ponding joint on the opposite side, then to the other toes and the ankles. Later the fingers and wrists may be invaded, but almost never the largest joints. With the progress of the affection the chalk deposits slowly increase until the characteristic deformity is produced. The skin covering the tophi may ulcerate, exposing the chalk-stones, an unmistakable picture. When the fingers are affected we note a deflection at the second or third joint, constituting a peculiar habitus.

Among important *associated conditions* are chronic gastric catarrh, arteriosclerosis, cardiac hypertrophy with considerable functional disturbance of the heart, and "contracted kidney," forming a much complicated yet easily recognized clinical picture. If in cases of this sort the *urine* of a gouty person is carefully examined, and is found to contain a small percentage of albumin and tube-casts, the whole train of events becomes easy of interpretation. The cases may be divided into two classes: (a) those in which the complexion is florid and the general health vigorous; (b) those with pale, sallow facies, emaciation, and enfeeblement. These groups are chiefly dependent upon the differences in the etiologic factors. Gouty subjects often manifest unusual mental vigor.

The *course* of chronic gout is liable to be interrupted by acute exacerbations with fever, during which dangerous complications may arise—*e. g.*, uremia, pericarditis, pleurisy, pneumonia.

4. Irregular Gout.—Says Sir Dyce Duckworth: "Gout manifesting itself anywhere but in a joint is to be considered irregular or incomplete." Such cases are confined chiefly to persons of gouty heritage, though I feel confident that the diathesis may be also acquired. Irregular gout rarely occurs in persons who have had previous typical attacks, but should the conditions described below be associated, or should they alternate, with acute gout, they may be ascribed to the latter. On the other hand, when these conditions occur in persons who are free from hereditary taint, and who are not addicted to the intemperate use of alcohol, or excessive indulgence in the pleasures of the table, and are not possessed of luxury- and rest-loving temperament, the diagnosis of irregular gout is to be made with caution. It is justifiable to apply a therapeutic test when other means of diagnosis fail.

The features of irregular gout are exceedingly diversified; the following are the more important:

(a) *Joint and Muscle Pains.*—The muscular pains may be anywhere and "flying" in nature, but the muscles of the back of the neck, the lumbar region, the abductors of the thigh, and the gastrocnemii are especially liable (Tyson). These pains are most severe in the early morning hours and subside as the day grows. Articular pains attended with some degree of swelling and deformity of the joints (the latter, however, not due to uratic deposits) may be of gouty origin; and, according to Paget and Garrod, Heberden's nodosities (previously described under Arthritis Deformans) may present vesicular eminences due to gout.

(b) *Gastro-intestinal Disturbances.*—In one of my cases intestinal colic followed by diarrhea put in an appearance at long intervals. Tonsillitis, pharyngitis, and parotitis may be manifestations.

(c) *Cardiovascular Symptoms.*—In atypical gout the increased amount of uric acid usually present in the blood, by increasing the blood-tension, excites arteriosclerosis and chronic interstitial nephritis—affections which are fully described in appropriate sections of this work. Occasionally pericarditis is a manifestation.

(d) *Nervous Manifestations.*—The different varieties of headache, including migraine, are common. Sciatica and other forms of neuralgia, tingling,

itching, burning sensations, and even pain in the palms of the hands and soles of the feet, are of frequent occurrence. Hot and itching eyeballs are, according to Hutchinson, among frequent manifestations; apoplexy may arise secondary to atheroma induced by gout; and rarely meningitis (basilar) is among the gouty morbid states. The latter also include certain psychopathia—insomnia, irritability of temper, and melancholia. The possibility of gouty neuritis is to be remembered.

(e) *Urinary Symptoms*.—From the gross specimen of urine or from qualitative tests it is impossible to tell the amount of uric acid that is being eliminated. The precipitation of urates or uric acid crystals does not imply that an individual is gouty. Such occurrence is dependent on many factors, the most common probably being a lessened excretion of urine with consequent insufficiency of fluid to hold the uric acid in solution. The only exact method is to estimate the twenty-four-hour elimination on a known diet. It will be found that just previous to an acute attack the uric acid is lower than the usual level. McClure¹ holds that faulty elimination of exogenous uric acid may be due to the fact that the gouty kidney is often functionally deficient. In the first part of an attack the output is markedly increased, with a subsequent fall. In the period between an attack, on a purin-free diet, the output is approximately close to the normal figures, 0.3 gram a day. Gouty persons are liable to gravel. I agree with Tyson, however, in thinking that the two conditions more frequently alternate than coexist. Intermittent glycosuria is also common in gouty subjects, and may lead to true diabetes mellitus; this glycosuria may alternate with uric acid showers. With these affections—intermittent glycosuria and gout—obesity is not uncommonly associated. Grandmaison believes the association of albuminuria with gout to be a frequent one, and that the early albuminuria is often intermittent. Zuelzer² has observed an increased elimination of uric acid in gouty subjects after the use of atophan, and Weintraud has shown that uric acid injected intravenously into gouty subjects is retained for a long time unless atophan be given—a diagnostic sign. Among grave secondary affections chronic interstitial nephritis, with its characteristic features (slight albuminuria and later casts), very common develops sooner or later, and cystitis (with hemorrhage into the bladder), urethritis, prostatitis, and orchitis all may be dependent upon gout.

(f) *Pulmonary Disturbances*.—Chronic bronchitis, to which asthma and emphysema may be secondary, is often associated with podagra.

(g) *Cutaneous Eruptions*.—Eczema is frequently associated with the gouty diathesis, and I have often observed eczematous eruptions alternating with the symptoms of bronchitis or gastric catarrh.

(h) *Ocular Disorders*.—The chief eye symptoms are conjunctivitis and keratitis (with tophi in the cornea and eyelids), iritis, hemorrhagic retinitis, and glaucoma. Gouty involvement of the ear (external canal and the auricle particularly) occurs oftenest late in life, though hereditary gout may rarely cause ear symptoms shortly after birth.

Differential Diagnosis.—The distinction between typical acute gout and acute articular rheumatism is a simple matter. But when, as is rarely the case, the former manifests itself as a polyarthritides, the discrimination may be difficult. W. H. Thompson has pointed out that in gouty polyarthritides, when the knees, elbows, and phalangeal finger-joints are affected, the points of greatest tenderness on transverse pressure are over the condyles. On the other hand, in acute rheumatism the points of maximum tenderness correspond with the tendons anterior and posterior to the joints. Moreover, gout dis-

¹ *Arch. Int. Med.*, 1917, xx, 641.

² *Berl. klin. Wochen.*, 1911, xlvii, 2101.

tinguishes itself by its previous history (heredity, alcoholism, gluttony), by the tophi, which may be first detected in the ears or conjunctivæ, by the development of contracted kidneys, and the less marked fever. After repeated attacks deformities of the joints ensue. In a doubtful case the blood may be studied. The average amount of uric acid in the blood of 21 cases of genuine gout studied by Pratt was 3.7 mg. per 100 grams of blood, as compared to the normal 1.7 mg. Folin and Denis recommend a simultaneous estimation of the non-protein nitrogen of the blood as a diagnostic aid because in gout the latter is rarely above the normal figures; in arthritis it is usually well above the normal, while the blood uric acid in both conditions is well above normal. Roentgenograms of gouty epiphyseal joints will frequently show small dark circles with well-defined borders, the result of bone absorption from areas in which sodium urate has been deposited.

Chronic rheumatism is distinguished from gout by the fact that the latter disease involves chiefly the small, and chronic rheumatism chiefly the large, joints. Moreover, chronic interstitial nephritis and arteriosclerosis, with their varied and often serious consequences, are frequently attendant upon gout, but not upon chronic rheumatism.

To differentiate chronic gout and *arthritis deformans* may be difficult, but the following table will indicate the main points of difference:

GOUT	ARTHRITIS DEFORMANS
Frequently hereditary.	Not so.
Causes are chiefly dietetic.	Causes chiefly infectious foci.
Affects males and the better classes most frequently.	Affects females and lower classes most frequently.
Begins in the big toe and extends to other toes; it is unilateral.	Begins in the fingers, which point to the ulnar side; develops in symmetric order.
Attacks are periodic.	More steadily progressive.
Deformity due to tophaceous deposits.	Deformity due to exostosis and ankylosis, and more marked.
Uric acid in excess in the blood.	Not so.
Complications (nephritis, arteriosclerosis).	Very rare.

Treatment.—(1) **Prophylaxis.**—In order to prevent the development of gout, especially in persons who have inherited or acquired a strong predisposition to the disease, temperate and even rigid habits of living should be adopted. Alcohol, particularly the heavier wines (Madeira, port, sherry, champagne, etc.) and heavier malt liquors, must be eschewed, and the patient must eat sparingly of concentrated meat (particularly red meat). A residence in the country with active out-of-door exercise is of paramount importance, but straining efforts, both mental and physical, are to be avoided. The climate should be temperate and moderately dry. The sleeping apartments should be capacious, well ventilated, and free from draft, and the action of the skin is to be favored by cleanliness and, if the patient be strong, by a cold bath in the morning with friction. For the robust, Turkish baths at intervals of two or three weeks constitute an excellent measure. In debilitated patients warm baths on retiring are preferable, and the chilling of the skin surface is to be carefully guarded against. The patient should wear flannels.

(2) **Active Treatment.**—(a) *Dietetic.*—"There is no diet for gout, but there is a diet for the patient" (H. C. Wood). The amount of food must be lessened as a rule, and taken at regular intervals. On the other hand, spare gouty subjects are met with, and in such I have found a generous diet, including fat-producing foods, of great service. During an attack we should attempt to overcome the perverted metabolism of the liver and gastro-intestinal tract,

and to minimize the production of the purin bodies. Broadly speaking, the dietary should be constituted as follows: *succulent vegetables* (cabbage, salads, string-beans); *fruits* (except bananas, tomatoes, and strawberries); *farinacea*, as rice, hominy, and the like (oatmeal to be avoided); *meats* should be restricted; beef and mutton in moderation may be allowed except in well-marked cases of gout; oysters and fish (except those that contain too much purin, salmon, smoked herring, canned sardines, mackerel, halibut, salt codfish, flounder), and fowl, particularly the white meat of chicken, are permissible; *fats* in the form of good butter may be taken freely—from $2\frac{1}{2}$ to $3\frac{1}{2}$ ounces (70.0–100.0) per diem—according to Ebstein; *milk* is entirely unobjectionable, and should be used in large quantities. If whole milk does not agree, it may be mixed with an equal part of Vichy. According to Kolisch, eggs are not objectionable. *Stale* breads may be used. Occasionally patients do best on albuminoids, while, on the other hand, with about equal frequency they improve on a vegetable diet; but a mixed diet is best adapted to the vast majority of the cases. Among articles to be avoided are pastry, tea and coffee, hot bread and cakes, sweet puddings, cheese, dried meats, and all highly seasoned dishes.

Beverages.—Alcohol is ordinarily to be interdicted. Champagne, Tokay, Port, and malted liquors are injurious in their effects, but clarets, Rhine, and Moselle wines can often be taken without unfavorable results.

Mineral waters, particularly the alkaline, are highly advantageous, and sometimes are even curative. Their value, like that of the warm baths and systematic exercise, is dependent upon their power to increase renal elimination. Whether they promote solubility of the uric acid in the blood is questionable; moreover, according to the observations of Klemperer, this is not a rational indication. The carbonate and citrate of lithium are efficient diuretics, but have no other claim to virtue in this disease. Among natural waters of special value abroad are Vichy, Carlsbad, Homburg, Ems, Kissingen, Aix, Buxton, and Bath, and in this country Saratoga and Bedford. These waters are to be taken in large quantities and when the stomach is empty. It is highly probable that the environment, rigid system of hygiene, including exercise and an appropriately modified dietary, play the principal rôle in producing the favorable results obtained at these noted springs.

(b) *Medicinal Treatment*.—During an acute attack the pain, if excruciating, is to be relieved by a hypodermic injection of morphin, which is to be followed by a purgative dose of some mercurial. Colchicum is almost a specific remedy, and must be administered, in the form either of the wine or the tincture, in doses of mxx to xxx (1.3–2.0) every four hours. It alleviates the inflammation and promptly relieves the pain, but its effects during the attack should be carefully noted. The salicylates may also be given to relieve pain. After the paroxysm it should be continued, though in small doses, combined with the citrate or bicarbonate of potassium or lithium. Atophan is a drug which has been definitely shown experimentally to lessen the amount of uric acid in the blood. Unfortunately, it cannot be bought in the open market at the present time. Gudzent reports success with radium emanations (by inhalation in a closed room) two hours daily; this agent causes the disappearance of uric acid from the blood. The limb should be raised and the affected joint or joints wrapped in flannel or cotton-wool. Warm alkaline solutions or hot fomentations often afford relief in the worst cases, and anodynes may be tried locally. The diet should consist chiefly of milk and egg-white during the attack; later rice, eggs, fish, and other light forms of meat may be added, the more liberal dietary previously indicated being slowly resumed.

In the *intervals* between the acute attacks the prophylactic and dietetic measures previously mentioned are to be resorted to in order that recurring

paroxysms may be prevented, and, in addition, the alkaline diuretics and saline laxatives, together with warm bathing, will be found of value. Hepatic stimulants yield good results.

In *chronic* and *irregular forms* of gout medicines are of subsidiary importance, and are in no wise comparable in their beneficial effects to the previous recommendations. Piperazin has been warmly advocated in all forms of gout for its supposed effect as a solvent of uric acid, and clinicians are almost unanimous in reporting its favorable results. Its beneficial effects are probably due to its diuretic action. The dose is gr. v to x (0.3–0.6) thrice daily, freely diluted with water. The late Sir William Roberts recommended potassium bicarbonate (3ss—2.0, in a tumbler of water at bedtime) to stem the nightly acid tide. Some authors highly recommend the salicylates for acute attacks of gout, both primary and intercurrent, in the course of the chronic form. In my own experience they have been less effective in this disease than colchicum. W. Denis states that benzoic acid, administered in large doses (8 gm. to 5ij per day), increases the uric acid excretion in the urine and decreases the uric acid content of the blood. C. von Noorden and L. Schliep have shown that there is a certain tolerance for nucleins in gout; and in every case its exact degree should be determined by allowing a definite number of grams of meat per diem and extracting the uric acid, the diet being restricted accordingly. Luff has demonstrated by experimentation the negative value of the alkalies and salicylates in the treatment of gout. If nephritis or a failure of compensation be present, even the former remedies should be administered with extreme caution.

For *chronic gout* potassium has been much used, though with slight advantage to the patient, I think. Fenner lauds a sterilized solution of thyminic acid (gr. ij—0.13) by intramuscular injection in subacute and chronic forms of podagra. A small dose (gr. iv—0.26) daily after meals for three months, and then every alternate week, tends to avert the onset of acute symptoms. The bitter tonics, combined with a vegetable salt of iron, as well as change of climate, should be resorted to in the anemic, debilitated class of gouty patients.

RACHITIS

(*Rickets*)

Definition.—A constitutional disorder of childhood, exhibiting developmental anomalies, chiefly in the bones and cartilages, causing deformities.

Pathology.—A mere summary of the anatomic characters can be given here. There is a derangement of the nutritive processes which retards and otherwise modifies the growth of the bony skeleton, particularly of the skull, the ends of the ribs, and of the long bones. The latter soften or remain unduly flexible as the result either of the absorption of ossified structures or of the greatly diminished deposition of lime-salts. Longitudinal section of the long bones shows the seat of the chief changes to be at the junction of the epiphysis with the shaft. In health we note at this point two thin layers, an outer (next to the epiphyseal cartilage) proliferative zone, and an inner layer (of ossification). In rachitis both zones, though more particularly the proliferative, are greatly thickened, much softened, and their margins irregularly notched. The periosteum is thickened and easily separable from the shaft.

A microscopic examination shows an increased rate of proliferation of the

plain the productive lesions described under Pathology. According to another view, which is supported by experimental proof, rachitis is apt to develop when the amount of both proteins and fats is low. Certain forms of diet predispose to rickets, probably for the reason that they do not supply certain necessary substances in adequate proportion, yet some children will develop rickets on the same diet that other children are taking without the development of the disorder. Hess and Unger¹ in their study of this problem conclude that the theory of Mellanby,² that if a child is deprived of fat-soluble vitamin rickets develops, is untenable. The question of the diet has always played an important part in the theories as to the causation of rachitis. The calcium deficiency is the most important factor undoubtedly, but how this arises is the question to be determined. Is it due to insufficiency of calcium in the food? Is it a result of a disturbance of calcium metabolism whereby the calcium of the food cannot be properly utilized or is excreted in excess? Is it a manifestation of disturbance of one of the internal secretory glands? Is it due to the want of a vitamin? (7) *Age*.—Of 903 cases, more than 75 per cent. occurred before the end of the second year, but of these, only 99 commenced during the first half-year (Bruennische, Von Rittershain, Ritsche). It may occur as late as the tenth year. (8) *Sex* is without effect. (9) *Syphilis*.—Divers views are entertained regarding the rôle played by syphilis as a cause of this disease. It cannot be denied that syphilis brings about a marked impairment of nutrition, so that the disease may engender a predisposition to rickets. (10) Findlay attributes rickets to lack of exercise and confinement.

Bacteriology.—Mircoli contends that it is produced by the action of ordinary pyogenic organisms upon the osseous and nervous systems, and Koch claims that the skeletal changes can be produced by injection of types of streptococci.

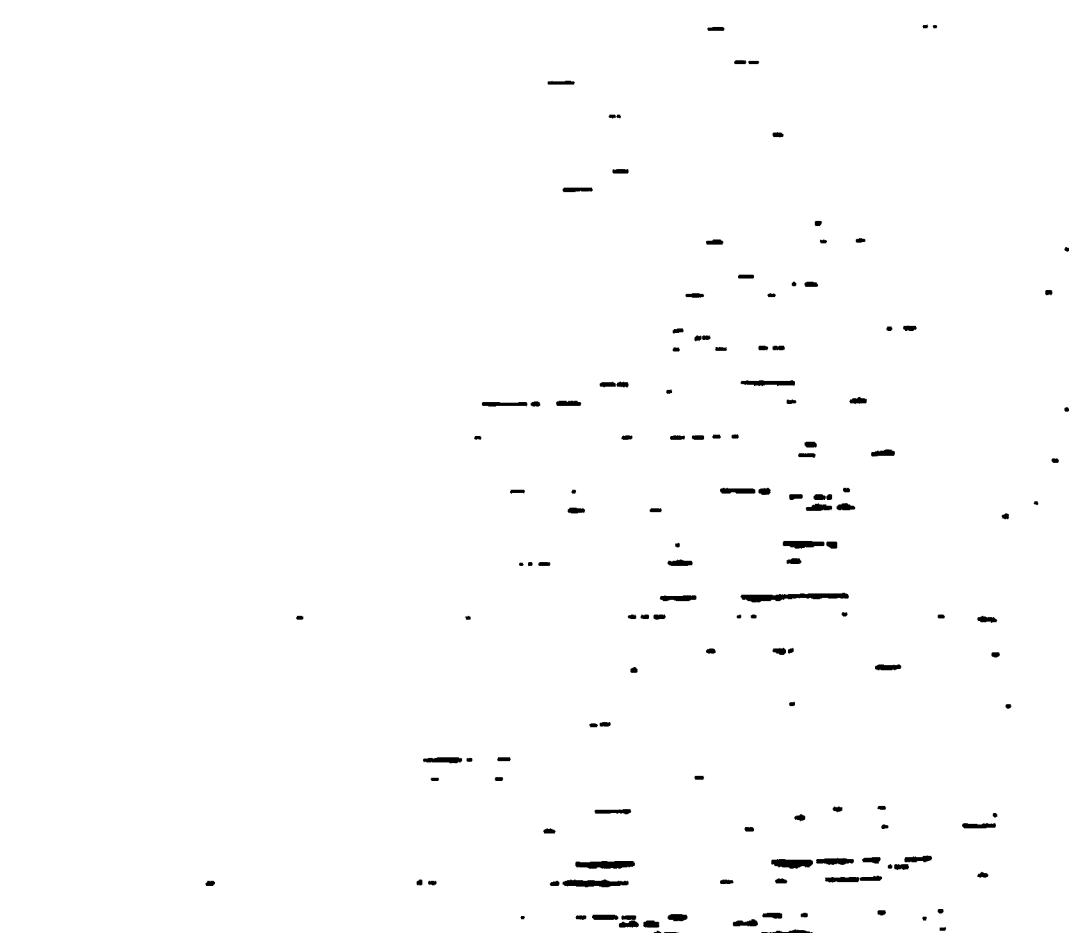
Symptoms.—The onset is *slow*, and the symptoms of gastro-intestinal catarrh, with their usual effect upon the general nutrition, may precede or accompany the true rachitic symptoms. At the beginning the infant is restless, irritable, and sleeps poorly, and slight fever is present in some cases. About the head and neck the child perspires freely, especially when asleep, wetting his pillow while the rest of the bed is dry. It is also annoyed by the bed-clothes, which it continually throws off, lying exposed even in a cool temperature. Among the *earlier symptoms* is a tenderness both over the bony surfaces and the soft parts, so that the patient wishes to keep still and dreads to be handled. The child is languid and disinclined to move his limbs or to walk or play, even if he has done so previously.

The symptoms are progressive in their development, rachitis being ordinarily a chronic disease, so that after many months more pronounced features, including various bone deformities, appear. Owing to the impairment of nutrition of the muscles the use of the limbs may become impossible, and these cases have been spoken of by writers as "rachitic paralysis"; this, however, is a misnomer. Cases have been reported by Berg and others that resembled spastic paralysis, pseudohypertrophic paralysis. Urinary phenomena are neither constant nor characteristic. In the active stage calcium excretion by the kidneys is low, by the intestines very high. When healing takes place, the ratio is changed and is associated with a retention of calcium. Secondary anemia of mild grade supervenes, the hemoglobin often being comparatively low, and there may be a leukocytosis.

The first rachitic *osteal changes* are presented by the cranial bones, the ribs, the radius, and the ulna. The cranium appears enlarged, though this enlarge-

¹ *Jour. Amer. Med. Assoc.*, 1920, lxxiv, 217.

² *Lancet*, 1919, i, 407.



...an enlargement of the lower end
...The radius and ulna are
...the fact that some of the
...crawling. The clavicle
...and occasionally the scapula
...upper extremities are rare as compared
...the cerebræ and intervening cartilages
...nature, usually anteroposterior.

These deformities are not uncommon, and are of no little importance in
...bearing upon the questions of marriage and subsequent labor.
...often forward and more rarely outward; swelling
...the first change to be observed in the
...In some well advanced cases the heads of the bones of the

R. Olei phosphorati, $\mathfrak{m}\mathfrak{x}$ (0.6);
Olei olivæ, q. s. ad $\mathfrak{f}\mathfrak{z}$ ij (60.0).—M.
Sig. Teaspoonful three times a day after feeding.

Kassowitz, Swetchen, and others, however, observed cases with cure; hence the remedy deserves a trial.

When it is desired to administer cod-liver oil and it is not tolerated by the stomach, it may be rubbed gently into the skin of the thighs and trunk. Arsenic in small doses has proved to be a capital remedy in selected cases; and iron, particularly in combination with arsenic, is indicated if anemia is pronounced. Klotz recommends pituitary extract, supplementing it with calcium carbonate to supply material for bone growth. Grosser recommends subcutaneous injections of calcium glycerophosphate. Rohmer recommends the combination of high calcium doses (\mathfrak{z} j to ij—4.0–8.0) per day until symptoms have disappeared, then about gr. xlv (3.0) for several months with phosphorized cod-liver oil in the treatment of rachitis.

The numerous *complications* to which rachitic subjects are liable present special indications which are to be met by the same measures as when they arise under other circumstances. The condition of the digestive organs must be kept constantly in mind; and no remedy, however promising, that is designed to assist the general condition should be continued if it tends to aggravate the digestive disturbance. Ewart advises massage for the abdominal atony and also the use of an elastic belt, which gives support to the abdominal parietes and improves circulation and respiration. The treatment of the rachitic deformities belongs to the domain of the orthopedic surgeon and should be undertaken early.

PART IV

NUTRITIONAL DISORDERS

BERIBERI

(*Endemic Multiple Neuritis; Kakke; "Weak legs"*)

Definition.—Beriberi is a specific disease characterized clinically by fever, muscular weakness followed by muscular atrophy, pain, tenderness, paresthesia, gastro-intestinal disturbance, tachycardia, and often general anasarca.

Historical.—Beriberi, first recognized by Strabo among the soldiers in the Roman armies while occupying Arabia (24 B. C.), was not grouped with the infections until the beginning of the nineteenth century. At this period the subject began to receive the serious attention of Dutch and (a little later) of Anglo-Indian writers and investigators. As stated by Osler, however, we may date the modern study of the disease from Malcolmson's monograph, published in Madras in 1835. It remained for Sheube and Baelz to point out that the principal morbid lesions are those of a multiple peripheral neuritis. It has not been until the last few years that the conception came into general acknowledgment that the disorder was one of faulty nutrition, and not infectious in nature.

Distribution.—The disease occurs chiefly in (1) Asia, Japan, parts of China and India, the Philippines, Dutch East Indies, and Malay States; (2) Africa, and (3) the northern and eastern coasts of South America. In these places it occurs only among the natives, whose staple carbohydrate food is rice. Instances of apparent epidemics on ship-board, in armies,¹ and so on have been shown to be due entirely to improper dietary. In England and along the Pacific Coast, among the Japanese and Chinese, it is not uncommon at the seaports (Fig. 34).

Pathology.—The essential feature is the changes in the nerves; these are inflammatory and degenerative, involving the medullary sheaths and axis-cylinders. In addition to the peripheral nerves, the pneumogastric and phrenic may be affected. Degeneration in the muscles also occurs, and, not uncommonly, serous effusions and edema. The right heart is frequently hypertrophied.

Etiology.—Largely through the researches of Funk, Osborne, Mendel, and others it has been shown that definite substances besides the proteins, fats, carbohydrates, salts, and liquids must be present in the food in order to insure growth, development, and the normal carrying on the bodily functions. To these substances Funk applied the name "vitamins," and the disorders produced by their absence from the food have been termed *nutritional disorders*, *deficiency diseases*, the *avitaminoses*, the *dietary diseases*, and similar terms. These necessary to health substances have been labeled by McCollum, "fat-

¹ Riddell, Smith, and Igaravidez (*Jour. Amer. Med. Assoc.*, 1919, lxxii, 569) report 60 cases in the 373d Porto Rican Regiment, the majority of which promptly improved when put upon a high protein diet.

soluble A" and "water-soluble B." They are unidentified chemical substances, the first found in certain fats, notably of egg and milk, the latter unassociated with either vegetable or animal fats. Drummond¹ looks upon them as resembling enzymes rather than chemical substances. They occur in combination usually with the protein portion of the food, but are called upon to play an important rôle in the starch metabolism. They are necessary for the correct nourishment of an individual. Beriberi has been more carefully

Fig. 34.—Beriberi (Hersog, in *Philippine Journal of Science*).

studied than any of these disorders and has been "fairly definitely attributed to be due to the absence from an unbalanced rice diet of certain vitamins contained in the coatings of rice grains but which are removed in the process of milling."² The coatings thus removed in polishing rice are the pericarp, the outer layer, and the aleurone layer, the next coat which contains a large amount of fat. The evidence that beriberi arises under these conditions is based upon the following facts: A diet of polished rice will produce beriberi in man in about three months. Polyneuritis gallinarum can also be produced in fowls by feeding polished rice. In the Philippines the chief cause of infantile mortality is the so-called infantile beriberi, a disorder occurring in sucklings of mothers who are the victims of beriberi, or who had it at one time and characterised by the absence of paralysis and a tendency to oliguria. The disorder is often cured simply by the administration of extracts of rice polishings. A striking diminution in the number of cases in Japan followed the introduction of an improved dietary.

In spite of the evidence that seems to indicate the true etiology of the disorder their still exists some doubt as to the nature of the disease.

¹ *Jour. Biochem.*, 1919, xiii, 8.

² *Jour. Amer. Med. Assoc.*, April 22, 1916, p. 1314.

Differential Diagnosis.—Other forms of infectious polyneuritis are distinguished by the absence of the peculiar endemic or epidemic status, the visceral symptoms, the edema, and of the transudation in the serous sacs. In *alcoholic neuritis* the peculiar history and such characteristics as the prevalence of painful features and trembling are noted; in *diphtheritic multiple neuritis* the *velum palati* is involved.

Course and Prognosis.—The course is interrupted by periods of aggravation and apparent pauses. The prognosis is mainly dependent on the intensity of the infection, the presence or absence of associated diseases, and the circumstances of the individual patient. The particular variety present in the case in hand influences greatly the outlook, *e. g.*, the cardiac or pernicious form being highly threatening to life. Again, the anatomic seat of the nerves implicated decidedly affects the prognosis.

The *mortality* differs with the seasons and locality. In Japan the death-rate is only 12.5 per cent., while among the Chinese and Brazilians it is much higher. Abdu says that mortality in beriberi averages 33 per cent.

Treatment.—1. **Prophylaxis.**—This depends entirely upon a proper diet. The rice, when constituting the large part of the food of the individual, should not be polished. Better yet is a liberal mixed diet with plenty of fresh food, particularly the leguminous vegetables.

2. **General Treatment.**—In mild and chronic cases a change of diet is usually all that is necessary to effect a cure. Food subjected to a high temperature, as in canning, should be avoided, but undermilled rice is permitted. In more severe cases an extract of rice polishings is recommended by Vedder. Likewise in infantile beriberi an extract of rice polishing may be given the child, who should be fed on animal milk. A nourishing *diet* is demanded, and rectal feeding must be instituted as soon as it is found that food cannot be administered *per oram*, or the food may be introduced by means of a small stomach-tube or catheter passed through the nostril.

The patient should occupy a secluded room with little light and a carefully regulated temperature. A single nurse will suffice, and all sources of external irritation should be avoided.

Drugs are indicated only in the treatment of the complications. In cases in which serious cardiac dilatation supervenes, venesection for its immediate effect is often effective in saving life. Many of the most distressing symptoms in acute forms (dyspnea, pain, nausea) are benefited by the use of morphin hypodermically. The dropsy of the cardiac cases requires rest and saline laxatives, followed by digitalis (m_v-x of the tincture every third hour). For the so-called cardiac seizures, nitroglycerin or inhalations of the nitrite of amyl are recommended. The atrophied muscles should be treated with electricity and massage, and strychnin with tonics is indicated for the same condition.

Stimulants hypodermically should not be spared when the heart's action becomes quick and feeble. The spasms are best controlled by chloroform inhalations, and during the intervals the patient should be kept under the influence of morphin, administered subcutaneously. Kintzing¹ reports excellent results from a solution of pure phenol (10 per cent. strength) in sterile water. Of this solution the adult dose employed was 10 drops diluted, by hypodermic injection deep into the muscles, and repeated every three hours in the beginning, increasing the interval as improvement manifested itself. Among other capital remedies are chloral hydrate and Calabar bean. The former may be exhibited by rectal injection (gr. xl—2.6 at a dose), to be repeated at intervals of six or eight hours until the spasm is overcome. The heart, however, must be carefully guarded. Rarely chloretone, potassium bromid, curare, nitrite of amyl, belladonna, and cannabis indica are useful.

¹ *New York Med. Jour.*, December 23, 1911.

Symptoms.—Scurvy has a *slow* onset. The earliest symptoms are generally a swelling around the eyes, over which the skin has the color of a bruise, and a pale face, which looks bloated and wears an apathetic expression. There is noticeable almost from the start a gradually increasing debility, emaciation, an inability to perform mental or physical labor, and despondency. The patient experiences arthritic and muscular rheumatoid pains and dyspnea on slight exertion.

With rare exceptions the *gums* swell, sometimes enormously, and become spongy, bleeding most readily. They may become ulcerated, and may be, though rarely, fungoid in appearance. The *teeth* often become loose, and in rare cases drop out. The *breath* emits an offensive odor that is sometimes due to necrosis of the jaw. The *tongue* swells, though it is usually clean and often pale. In the mouth may be observed submucous hemorrhages in many cases. There is loss of appetite, but the digestion is usually good; there may, however, be constipation or diarrhea, more frequently the former. Albertoni has shown that in scurvy of a protracted course free hydrochloric acid is absent from the gastric juice, and that the total acidity is much reduced, but this is so neither in every case nor at all stages of the disease. *Scorbutic dysentery* has been described by certain writers. The *skin* is dry and of a muddy color, blended occasionally with a greenish or greenish-yellow tinge. At the end of a week or ten days *petechiæ* and *ecchymoses* appear upon the legs, arranging themselves about the hair-follicles. These may also come out later on the trunk and upper extremities. Submucous hemorrhages may give rise to circumscribed swellings, and *subperiosteal hemorrhages* may occur and engender node-like protuberances. There may be frequently noticed a peculiar brawny induration due to extensive hemorrhagic infiltration of the muscles and subcutaneous tissues, most marked in the hams and calves. The condition is not without considerable *pain*, particularly if the parts be touched, and in severe cases bullæ and vibices may be seen, as in a recent case of my own. Hemorrhages from the mucous channels of the body occur and epistaxis is frequent. In bad cases hematuria, also melena and rarely hematemesis, may be observed. Blood may be effused into the serous membranes, accompanied sometimes by inflammatory changes in the latter; also into the lungs, which are rarely the seat of secondary pneumonia. Pulmonary infarction occurs, but is a rare event. Hemoptysis may be a symptom of the lung complications or may occur as an independent phenomenon.

The *heart* may present symptoms, such as palpitation, feeble impulse, arrhythmia, and sometimes a basic blood-murmur, but these are without diagnostic importance. The pulse is soft, small, and on exertion much accelerated. Heitz found a tendency to anemia, with whites somewhat below normal and slight polynucleosis. The *temperature* is sometimes subnormal, and the presence of fever is a certain indication of the existence of some complication.

The *nervous symptoms*, aside from the profound mental depression, are not prominent. Insomnia may be a distressing symptom. Delirium (late) is sometimes witnessed. Meningeal hemorrhage may supervene. Both night-blindness and day-blindness are among the rarer and extraordinary ocular features.

The *urinary symptoms* vary in different cases. Albuminuria is common. The specific gravity of the urine is increased, the color high, and solid constituents diminished, except the phosphates, which are abundant. Albertoni found the proportion of chlorids less than the normal, while other investigators claim that the percentage is high. *Nephritis* may occur as a complication. The bones in long-standing cases may be congested and sometimes necrotic,

of potassium chlorate is best. For swelling of the gums the application by means of a cotton swab of tannic acid (2 per cent.) or a solution of silver nitrate (2 to 5 per cent.) is serviceable. A combination of boric and carbolic acids in a solution of suitable strength may be used as a mouth-wash. If copious hemorrhages occur, hemostatics are eminently useful. The various complications must be met by the usual measures, according to their nature.

INFANTILE SCORBUTUS

(*Barlow's Disease*)

Definition.—A nutritional disease, characterized by the same symptoms as scurvy in adults.

Pathology.—The bones are thickened and excessively sensitive owing to a marked subperiosteal hemorrhage, with more or less maceration and want of firmness, between the epiphysis and shaft. The muscles may be the seat of effusion. The heart is frequently hypertrophied and dilated, particularly the right ventricle. The lesions of rickets are often associated.

The nature of the affection is similar to that of adult scurvy except in a few minor details. There is a deficiency of certain antiscorbutic substances in the dietary. As a result of this the characteristic symptoms occur. These may be reproduced in animals by feeding with a scurvy diet. The close relationship of scurvy with beriberi has been pointed out by Darling and by Hess.

Etiology.—Scurvy is largely confined to *hand-fed infants*, especially those reared upon the numerous infant foods which have been foisted upon the market, including condensed milk, etc. Louis Starr, Jacobi, and others have shown that it sometimes follows the prolonged use of sterilized milk, although the etiologic importance of the latter food has been overemphasized. An investigation by a committee of the American Pediatric Society in 1898 showed that of 379 cases the majority occurred between the ages of seven and fourteen months inclusive, and that the disease has a greater tendency to occur among the rich or well-to-do. "The farther a food is removed in character from the natural food of a child, the more likely its use is to be followed by the development of scurvy." Hess emphasizes the fact that this disease is an auto-intoxication due to the overgrowth of harmful bacteria in the intestines.

Symptoms.—The *skin* presents the muddy color peculiar to the disease in adults. The patient may be well nourished, but more often there is a tendency to *wasting*, and other symptoms of impaired nutrition appear, particularly irritability and disinclination to exertion. The more characteristic features appear after one or two months, and the child cries when handled, especially on touching the lower limbs. About the same time there is an irregularly cylindric swelling of one of the thighs due to subperiosteal effusion. Soon the other limb is similarly involved, though not always to a like degree. At first the legs are flexed, but later they become straightened and slightly everted on account of the progressive hemorrhage or separation of the epiphyses. The bones in other portions of the body may be involved secondarily in more or less rapid succession, but the swellings are less marked than in the lower limbs. Later, if the teeth be present, the gums may swell and become spongy. Ecchymoses in the form of petechiæ appear upon the skin surface, and particularly about the eyes. Other important findings include enlargement of the heart, edema not only in the eyelids but also over the lower end of the tibia, increase of the reflexes, and roentgenologic findings. The first definite finding in the early stages of the disease is the "white line" of Fränkel, which is shown by the roentgen ray at the epiphyseal ends of the long bones.

erythema of the skin, which goes on to desquamation, pigmentation, and ulceration.

Etiology.—The disease usually attacks the young. Negroes are less frequently affected than whites. The sex is more frequently female than male, while season seems to play a small part in the etiology of the disease. The inmates of asylums and the poorer class who depend largely upon cornmeal as a staple for dietary are most frequently affected. The Pellagra Commission of the New York Post-Graduate Hospital and Medical School found that since 1914 practically all the new cases of pellagra in two small towns in South Carolina developed while the person was residing in the same house with, or next door to, a pellagrin in the active stage of the disease, or within six months after such exposure.

The *pathogenesis* of the disorder has caused a great deal of discussion, and a large amount of work has been done upon it. Up to within the past few years Sambon's theory that the disease was transmitted by a type of specific parasite-carrying mosquito was very generally accepted. More recent study, however, by numerous investigators and observers, including Goldberger, Siler, Garrison and MacNeal, Wood, Vedder, and others, has shown that the disease is truly a deficiency disease. Dr. Vedder¹ summarizes briefly his conclusions, which tend to show that the disease is a deficiency disease: There is a distinct similarity between pellagra, beriberi, and scurvy, well-known deficiency diseases; the evidence that has been presented as proof of the infectious nature of pellagra can be explained by the deficiency hypothesis; a deficiency is present in the diets of most pellagrins as a result of too frequent use of wheat flour in association with cornmeal, salt meats, and canned foods, which are known to be deficient in vitamins. Goldberger² writes that the pellagra-producing dietary fault depends upon two or more of the following factors: "(1) A physiologic defective protein supply; (2) a low or inadequate supply of fat-soluble vitamin; (3) a low or inadequate supply of water-soluble vitamin; (4) a defective mineral supply." The hypothesis that it is a deficiency disease is extremely plausible.

In recent years the diet of the people of the South has been greatly modified. As Wood has pointed out, corn used to be crushed between two stones and the only portions removed were the coarse particles of the husk, while in the modern methods of making cornmeal the corn is subject to heat, after which the grain is degerminatized and about 30 per cent. of the germ, husk, and hull of the corn is removed, leaving a finely granulated cornmeal known as milled meal. By this modern process of milling the vitamin-containing portion of the corn is discarded. In addition to this, the poorer classes use too finely ground commercial wheat flour when they use flour other than cornmeal, which is also deficient in vitamins. The experimental proof of the pathogenesis can be found, for example, in the paper by Wood.³

Symptoms.—At the beginning are languor, debility, indigestion, anorexia, vomiting, and occasionally diarrhea. This is soon followed by erythema, pain, and roughness of the skin. Exfoliation of the latter reveals a suppurating surface. The erythema affects usually the exposed parts, beginning on the backs of the hands, the face, neck, and sometimes the feet. At first the involved areas resemble an ordinary sunburn, later becoming darker and desquamating, leaving behind some degree of pigmentation. In some instances bullæ and vesicles may appear. Recurrences are common and lead to puffy swelling and a thickened, indurated condition of the skin, which is now darker in color. Finally, atrophy of the skin may occur. The mucous membrane

¹ *Arch. Inter. Med.*, 1916, xviii, 137.

² *Jour. Amer. Med. Assoc.*, 1918, lxxi, 947.

³ *Amer. Jour. Med. Sci.*, 1916, clii, 813.

PART V

DISEASES OF THE BLOOD AND THE DUCTLESS GLANDS

I. THE PRIMARY OR ESSENTIAL ANEMIAS

PRIMARY anemias constitute those forms in which, so far as our present knowledge of their etiology and pathology goes, no other tissues or organs than the blood and the blood-making organs are either at fault or are directly affected. Future investigations of the life history of the blood may reveal the exact causation of what are now regarded as primary or essential anemias, and thus permit of a clearer discrimination and a more accurate classification.

CHLOROSIS

(*Green Sickness*)

Definition.—A blood disease, occurring chiefly in adolescent females, dependent upon defective hemogenesis, and characterized principally by a deficiency of hemoglobin in the red corpuscles. Chlorosis is steadily diminishing in frequency of occurrence.

Pathology.—It is so seldom that death occurs in cases of chlorosis that autopsies of this disease have not been frequent enough to determine definitely the nature of the findings. There is no loss of fat in the body, but signs of physical degeneration and disorders of development are quite common, hypoplasia of the vascular system and of the genital organs seeming to be the most prominent. Incurable cases of chlorosis are nearly always characterized by anomalies of the blood-vessels and genitalia (Rokitansky). Virchow has also shown that congenital arrest of development of the aorta and larger arteries, as indicated by their small size, their soft and elastic walls, is quite constant in chlorotics. The uterus (especially) and adnexa manifest the hypoplasia, and yellowish spots and streaks of fatty degeneration are sometimes seen in the intima of the arteries. The cardiac muscle is softened, the whole heart is dilated, and the left ventricle is usually somewhat hypertrophied.

Etiology.—Chlorosis occurs most frequently in girls at or near puberty, and also may appear between that period and twenty or twenty-five years of age. It usually happens that the condition dates from a scanty menstruation, beginning late in the "teens," but it should be recollected that amenorrhea is not, as formerly supposed, a cause, being rather an effect of the underlying blood disorder. Blondes are oftener affected than brunettes. In males the disease is rare.

Such *unhygienic conditions* as bad air, dimly lighted rooms, a lack of nutritious food and outdoor exercise, a sedentary occupation, excessive tea and coffee drinking; bodily fatigue, as from stair-climbing and standing in constrained positions without intervals of rest—all these predispose to the disease. And yet girls living amid the most luxurious and favorable surroundings have had chlorosis.

Sudden emotional excitement and prolonged mental overexertion operate as causative agencies. Shock from bad news, such as loss of relatives, homesickness, disappointment in love, rankling grievances, and perhaps ungratified sexual desires, may contribute to the "neuropathic" origin of chlorosis. A change of climate seems to operate as a cause, and is manifested especially in the case of girls emigrating from rural Ireland to enter domestic service here (Townsend). A *late chlorosis* has also been described, but its existence must be rare. The true *pathogenesis* of the condition is unknown. Virchow's theory of congenital hypoplasia of the blood-vessels and genitalia; Clarke's, of copremia; Meinert's, of splanchnoptosis, have been discarded. More recently the theory has come into quite general acknowledgment that chlorosis may be due to a disturbance of endocrin function, most likely of the ovary, resulting in deficient hemoglobin, anabolism or iron metabolism. That chlorosis is a secondary anemia, as, for example, from occult gastric hemorrhage, is disproved by the promptness with which it yields to iron therapy.

Symptoms.—A brief outline of the more frequent and prominent general manifestations of chlorosis—or "green sickness"—may be narrated at the outset. The gradual onset is usually marked by languor, indisposition to either physical or mental exertion, motor weakness, irritability or inertia of mind, and a more or less constant fatigue. *Palpitation of the heart* and *dyspnea* on slight exertion are much complained of in most cases; *headache* is also an early symptom, and may be accompanied by vertigo in some cases; and *dyspepsia* and *constipation* occur in 65 per cent. of cases (Townsend). Probably in one-half of all cases cessation of, or scanty and irregular, menses may form the burden of complaint. A slight fever is present in many instances.

Gastro-intestinal Symptoms.—The appetite is either poor or perverted and a capricious desire for such innutritious substances as chalk, slate-pencils, and even bits of earth (*pica*), or for sour, highly spiced, and unwholesome articles of food (*malacia*), is not uncommon. An abnormal craving for alkalies has been ascribed to an overacid stomach. Morning vomiting and eructations, as well as pain after eating, may occur. Dilatation of the stomach and high position of the diaphragm are found in many instances. The gastric contents show a hyperacidity in most cases. The tongue is pale, flabby, often dry, and the edges show indentations. *Constipation* is usually present, though sometimes *diarrhea*, lasting for a day or two, may alternate, as after the ingestion of some unwholesome article that has been eaten to satisfy the perverted appetite.

General Appearance.—The subcutaneous fat is not only well retained, but in many cases is even increased, and the rotundity of the body and members preserved. The peculiar *greenish-yellow tint* of the complexion is, however, the most striking manifestation to the eye. It differs thus from the muddy pallor of cancerous anemia, from the lemon-yellow tint of pernicious anemia, from the saffron hue of jaundice, and from the blanched pallor after severe hemorrhages. The *scleræ* are often pearly or bluish white ("cerulean hue"), and, though this is considered by many the earliest positive indication of anemia, when the skin tint is not characteristic, yet, according to Townsend's analysis of 87 cases of chlorosis, it is not the most constant. The *nails* showed pallor in 95 per cent. of the cases; the cheeks, tongue, and lips were pale in 89, 84, and 76 per cent. respectively, while the *scleræ* were pale in but 64 per cent. On exertion the cheeks and lips may become quite ruddy in cases of moderate anemia (*chlorosis rubra*).

Circulatory symptoms are breathlessness, palpitation, and the tendency to vertigo and syncope complained of in the majority of cases; other circulatory disturbances may occur. The *skin* and the extremities are frequently cold,

owing to sluggish heart action. The pulse is usually full and easily compressible, and, owing to its excitability, it may be accelerated for the time being by various external influences (Fig. 35). Visible undulating pulsations of the carotid vessels are frequent, and a pulsation at the base of the heart and in the peripheral veins is also observed at times. Physical examination shows the heart to be slightly dilated. Systolic murmurs, soft and "whiffing" in character, are heard at the base, though in severe cases they may be heard at the apex of the heart also. *Systolic blowing murmurs* of hemic origin are not infrequently heard over the carotid arteries. More common and characteristic, however, is the *venous hum* or *bruit de diable*—the soft continuous murmur heard over the large cervical veins. Thrombosis of the larger veins or of a cranial sinus may occur, and is always ominous.

Of the *nervous manifestations* that are often present, neuralgias of the head, mental depression, hyperesthesia of the skin, particularly of the abdomen, gastric attacks, and hysteria are most frequently met with. Tinnitus aurium and anemic amaurosis have been known to occur.

Fig. 35.—Pulse- and temperature-chart of a case of chlorosis, showing the effect exerted upon the pulse by eating, exertion, and excitement.

Edema of the ankles is found in perhaps one-third of the cases. The urine is generally pale, free in quantity, and its specific gravity is somewhat lowered; and according to recent studies there is a diminished excretion of urea, despite the abnormal destruction of albuminoids. Movable kidney is often associated.

Blood Examination.—The blood flowing from a punctured finger pulp or ear lobule is pale, though seldom thin or hydremic, and the paleness is due to a qualitative rather than a quantitative change. There is a disproportionate reduction of the hemoglobin as compared with the number of the red cells. The hemoglobin may range from 50 per cent. to as low as 16 or 17 per cent. In severe cases, the average quantity being about 38 or 40 per cent. On the other hand, the number of red corpuscles is not greatly reduced, and may even be normal. The moderate *oligocythemia* and marked *oligochromemia* are almost distinctive of chlorosis: these features, however, may be simulated by the chloro-anemia of syphilis or early tuberculosis. Morawitz calls attention

to "masked chlorosis," in which Seiler found that the hemoglobin percentage was only 10 or 15 below normal. The average number of red corpuscles is from 3,700,000 to 4,100,000 per cubic millimeter of blood, but the count in severe cases may be as low as 1,900,000. Approximately, the number of red corpuscles is from 70 to 85 per cent. of the normal, while the leukocytes are only slightly increased in number (8500 to 9000 per cubic millimeter). *Microscopically*, the red cells are seen to be paler than normal. Some are distinctively larger than is usual (macrocytes), but the majority are slightly undersized (microcytes). Irregularity in shape (poikilocytosis) is seen in quite a number of the red cells in the severe cases, and an occasional normoblast (nucleated red corpuscle of the size of a normal red cell) may be noted. There is usually a relative lymphocytosis, especially in severe cases. The eosinophils are occasionally increased (Cabot). There is a marked increase in the amount of blood-plasma (polyplasmia).

Diagnosis.—When the greenish pallor of the face is marked this can often be correctly made at a glance. The blood examination must be made, however, to completely establish the diagnosis, even when distinctive symptoms are present, such as the shortness of breath, palpitation, weakness and languor, faintness, amenorrhea, capricious appetite, together with a well-nourished appearance of the body. The bluish-white scleræ and pallid nails are confirmatory when observed, and search should be made for the physical signs.

Differential Diagnosis.—The primary character of the anemia may be determined in doubtful cases, or in those in which *incipient tuberculosis* ("chloro-anemia"), or *syphilis*, or *Bright's disease* may be suspected, by exclusion. Here the physical examination of the chest, the history, and urinalysis should supplement the blood examination. In the chloro-anemia of chronic phthisis, fever and progressive emaciation in association are also observed. Syphilis is readily excluded by the Wassermann test. *Organic disease of the heart* may be simulated by the breathlessness, palpitation, vertigo, and edema.

Prognosis.—This is always favorable. The discontinuance of proper treatment before a substantial cure is effected is often followed by a relapse, and even after apparent cure one or more recurrences may be witnessed before the age of thirty. The average duration of a case of chlorosis is from two to three months. In cases of very severe type, in which the dividing line between this disease and pernicious anemia may not be marked clearly, the prognosis should be made with due reserve.

Treatment.—While the treatment of chlorosis by the administration of iron is wellnigh specific, the *hygienic measures* are also important, and particularly in order that relapses may be avoided.

Hygienic.—Pure air, wholesome food, and plenty of rest and sleep, with regular habits, are prime requisites. Sometimes a change of occupation, even temporary, where confinement may be replaced by an outdoor life and sunshine, as in the case of store girls and mill operatives, is of value in bringing about a rapid improvement. Patients in better circumstances may be sent to rural districts, the mountains, or sea-shore. In cases marked by much palpitation, dizziness, and dyspnea, rest in bed for a week or so is often imperative at the outset. As improvement goes on, however, light and then moderate exercise may be permitted, and the increasing appetite should be gratified by a generous, easily assimilable diet (milk, meat, eggs, fish, purées of green vegetables, stewed fruit). Fats and carbohydrates should generally be avoided. Coffee, tea, and alcohol do harm. Hot baths have been recommended.

Medicinal.—The one remedy, *par excellence*, on both rational and empirical grounds, is a good preparation of *iron*. This should be given methodically and persistently until the percentage of hemoglobin is 90, and then maintained

there by continuing the administration of the iron for several weeks to prevent a recurrence (Fig. 36). Exactly how the iron acts in curing chlorosis has not been definitely proved, but its almost specific action is indubitable. Not all preparations of iron are equally well borne by the stomach, however, and several changes may be necessary during the course of a given case. Probably the best form for general use is the dried sulphate, usually given together with potassium carbonate in the well-known Blaud's pills—2 grains (0.129) of each to the pill. Starting with one pill thrice daily for a week or ten days, the daily dosage is increased until nine pills daily are administered in the third week, and continued for several weeks or as long as the case may require. It is very important meanwhile that the bowels should be kept soluble by the use of cascara sagrada, salines, and the like. Other iron preparations of

Fig. 36.—Chart of a case of chlorosis, showing the improvement following the administration of iron. Convalescence almost complete; relapse. Black, red corpuscles; red, hemoglobin; blue, white corpuscles.

value in this disease are the citrate, lactate, carbonate, the succinate, and the reduced iron. The albuminates of iron, so much vaunted for a time, are practically worthless. In severe cases Quincke uses at first a 5 per cent. solution of the ferric citrate hypodermically (mviiss to 3iiss—0.5–10.0, daily). Bitter tonics and dilute hydrochloric acid are indicated in a certain number of cases in which indigestion is troublesome. The acid tincture of iron chlorid is sometimes used in such cases. Mild cases often yield to the simple use of remedies for the cure of gastro-intestinal derangement. Arsenic is a valuable adjuvant to the iron treatment. It may be employed hypodermically as the cacodylate of soda (gr. $\frac{1}{10}$ —0.002) in combination with the hypodermic solution of ferric citrate, the solution being given every second or third day deep into the muscle (deltoid-lumbar muscles).

PROGRESSIVE PERNICIOUS ANEMIA

(Idiopathic Anemia; Addisonian Anemia)

Definition.—A grave blood disease characterized by a great destruction of red corpuscles, and a persistent tendency from a bad to a worse condition, with intercurrent remissions. It usually ends in death, and seldom exhibits causal lesions other than those of the blood or blood-making organs.

Pathology.—The subcutaneous fat is rarely diminished, so that emaciation is exceptional. The skin is pale and of a lemon-yellow tint, and most of the tissues and organs are anemic except the muscles, which are often decidedly red in color. The fat is usually pale and yellowish, and fatty degeneration is one of the most striking changes in this affection. According to Cabot and Richardson¹ cardiac hypertrophy is frequently found in pernicious anemia; 18 out of 19 cases that were autopsied at the Massachusetts General Hospital in a period of ten years showed a definite hypertrophy or dilatation. Microscopically, the fibers or columns of heart muscle are seen to be distinctly fatty. The heart cavities contain little light-colored blood. Other organs showing the fatty degeneration (of the epithelium) are the liver, kidneys, gastric and intestinal walls, and the intima of many of the smaller blood-vessels (in patches). This general fatty change is probably due to the deficient oxygenation of the tissues and to the anemic blood-supply.

Owing to the above degenerative change in the vessel walls small extravasations of blood are found in different parts. Most frequently these punctiform hemorrhages are seen in the retina and on the principal serous membranes. Ecchymoses are also observed occasionally on the mucous membranes and on the skin. More or less general edema and dropsical accumulations in the serous cavities are not uncommon. The spleen and liver are seldom and only slightly enlarged. The lymph-glands are often somewhat swollen and intensely red in color owing to the unusual number of red corpuscles.

In a series of 8 cases Warthin has found changes in the hemolymph glands consisting of "dilatation of the blood-sinuses and evidences of increased hemolysis, as shown by the increased number of phagocytes containing disintegrating red cells and blood-pigment."

A marked and important pathologic feature of pernicious anemia is the presence of abundant deposits of iron-pigment, especially in the liver, but also in the spleen, kidneys, pancreas, and other organs. The fact that the abnormal quantity of iron in the liver is peculiarly distributed about the periphery and middle zone of the lobules is particularly noteworthy, and quite characteristic of pernicious anemia. The origin of this iron is doubtless the enormous destruction of red corpuscles, and that the pigment in the hepatic lobules is ferruginous may be determined by a microchemic test with ammonium sulphid, granules of black sulphid of iron being formed.

Of special interest are the lesions found in the bone-marrow on account of its hematopoietic function. This is virtually hypertrophied, and is in many cases deep red instead of yellow, and more like the hemoblastic marrow of childhood (H. C. Wood). While formerly held to be causative, this change is now regarded as being secondary to the severe anemia. Cellular hyperplasia may be seen microscopically in the great number of large and small granular medullary cells, and also in the nucleated red cells.

An atrophied condition of the gastric and duodenal mucosa is noticed in some cases. The sympathetic ganglion cells may also show changes. More constant, however, is the sclerosis of the posterior columns and, to some extent, of the lateral columns of the spinal cord: this is especially marked, according to Burr, in the cervical swelling. Patveu examined 9 cases; in 4 he

¹ *Jour. Amer. Med. Assoc.*, 1919, lxxii, 991.

and hyaline degeneration of the vessels of the white substance, and in 5 small hemorrhages. These changes are probably due to a toxic agent. The same type of lesion is observed in the brain of those patients who have degenerative processes in the cord (Woltman¹).

Pathogenesis.—There are three categories into which cases of pernicious anemia may be grouped: (1) Those cases in which no discoverable cause for the hemolysis (blood destruction) is ascertained either during life or after death—i. e., the idiopathic variety of Addison; (2) those in which an adequate cause is found *postmortem* only; (3) those that are apparently traceable, *antemortem*, to some primary causal condition acting directly or indirectly.

(1) As regards the *obscure (genuine) cases* of idiopathic anemia, the essential cause of the symptomatic condition is evidently an actively increased hemolysis. The blood generation (hemogenesis) is usually normal or increased in power. Evidence of excessive hemolysis is seen in the deposition of pigment in the organs, in the excessive iron in the liver, and in the extremely marked excretion of urobilin in the stool. Evidence of exaggerated hemogenesis is seen in the nucleated red cells and Jolly bodies in the red cells in the peripheral blood-stream, as well as in the increase of skein forms, as demonstrated by vital staining, and in the red bone-marrow. Grawitz and Stengel believe that the hemolysis originates in the gastro-intestinal capillaries and depends upon poisons generated or absorbed from that tract—an auto-intoxication. Vogel favors the view that lipoids, which belong to the group of ether-soluble substances, are either the direct or indirect cause. Von Jaksch holds that the similarity of pernicious anemia to kala-azar suggests a protozoön infection. William Hunter concludes that the disease is of infectious (streptococcal) nature, dependent primarily upon caries of the teeth. Goullard and Goodall hold that a hemolytic toxin (not necessarily from the intestines) acts on the bone-marrow. That the spleen plays some part in the pathogenesis of pernicious anemia has been shown by Eppinger. Just what effect a perversion in the splenic function has has not been fully determined, but Eppinger believes that as a result of the pathologic changes in the organ increased hemolysis takes place in the splenic pulp.

(2) *Apparently causeless* cases of a pernicious type of anemia may be found *postmortem* to have been caused by (a) obscure malignant disease; (b) parasites, especially the *Ankylostoma duodenale*, and rarely by the *bothriocephalus*. Not infrequently, by a careful study of the anamnesis of a patient, aided by modern methods of examination, the cause of pernicious anemia may be detected during life. It is held that atrophy of ventricular and intestinal glands is an effect rather than the cause of the anemia, as formerly believed (Grawitz).

(3) Exhausting causes, operating directly or indirectly, may precede this affection, as severe or prolonged hemorrhages or diarrhea, fevers, mental shock, profound chlorosis, pregnancy, and parturition. Although these conditions are relatively frequent, the effect, a pernicious type of anemia following them, is extremely rare; in fact, that such occurrence is possible is doubtful.

Predisposing Causes.—Unfavorable hygienic surroundings and insufficient nourishment, habitually kept up, supposedly favor the development of the disease, but the disease is found as frequently in the private floor patients as in the ward patients. Males are more frequently affected than females after the thirty-fifth year and it occurs mostly during middle life. Griffith has collected several cases occurring under twelve years of age. The disease is widely distributed, and it may behave endemically at times, as in Switzerland and Leipsic.

¹ *Arch. Int. Med.*, 1918, xxi, 791.

the evening temperature sometimes reaching 102° F. (38.8° C.). Previous to death the temperature may be subnormal.

Nervous Symptoms.—There occur at times in pernicious anemia symptoms referable to the central nervous system. Woltmann,¹ in a careful neurologic examination of 150 cases, found involvement of the central nervous system in 80.6 per cent., and of these, 99.2 per cent. showed evidence of subacute combined sclerosis type of lesion. These symptoms may occur with only a mild degree of anemia, and at times seem to appear even before the anemia, as in the case reported by Bramwell. It is presumed that the toxin producing the anemia also exerts the pathologic effect on the cord, focal areas of degeneration of the nerve-fibers in posterior tracts. The symptoms are differentiated from the symptoms and signs of posterolateral sclerosis by but two findings: (1) loss of sense of position and (2) loss of vibratory sensation (inability to feel the vibrations produced by a tuning-fork placed on the bones). In all other respects the findings are similar to those of a syphilitic posterolateral sclerosis.

LABORATORY FINDINGS.—The *urine* is of low specific gravity, and, on account of its pigmentation with pathologic urobilin, which is due to the hemolysis of the red cells, may be dark in color. The urobilin is detected both by chemic and spectroscopic examination. In the former the addition of a few drops of an alcoholic solution of zinc chlorid to the urine gives a green fluorescence. The urobilin and urobilinogen are increased both in the urine and the stools, an evidence of increased hemolysis. They may be estimated by the method of Wilbur and Addis² or by a modification of this method (Boyd³) which is somewhat simpler. Albumin and glucose are absent, but uric acid and urea are both increased in amount, the former occasionally and the latter usually. Christian⁴ points out that "in severe anemia renal function, as measured by dietary tests, is disturbed in much the same way as is found in patients with advanced chronic nephritis," but without "the symptoms and physical findings of a renal lesion of the nature of a chronic nephritis." According to Kahn and Barsky,⁵ among other laboratory finds there is also noted increase of blood creatinin; acidosis is present frequently; and the pancreatic secretions are normal.

Blood Examination.—The blood is usually pale, though sometimes dark and watery, and the oligocythemia is distinctive of pernicious anemia. The number of red corpuscles may be reduced to less than 200,000 per cubic millimeter, and is seldom more than 1,000,000. The percentage of hemoglobin may be approximately proportionate to the number of red corpuscles in the earlier stages, but as the disease progresses the index rises, so that the individual corpuscles are rich in hemoglobin. In other words, although there is a reduction in the total amount of hemoglobin, it is usually not so great as the reduction in the number of erythrocytes; therefore the color index is nearly always relatively higher than that of the red globules (Fig. 37), a condition in marked contrast with chlorosis. Macrocytes (which cause the relatively higher percentage of hemoglobin), microcytes, poikilocytes, and polychromatophilia are present, and the former abundant. The presence of nucleated red corpuscles is also a striking characteristic of pernicious anemia. When normal in size they are known as *normoblasts*; when very large, as *megaloblasts*. In the former, according to Ehrlich, the eccentrically placed

¹ *Amer. Jour. Med. Sci.*, 1919, clvii, 400.

² *Arch. Int. Med.*, 1913, xiii, 235.

³ *Jour. Lab. and Clin. Med.*, 1919, iv, 495.

⁴ *Arch. Int. Med.*, 1916, xviii, 430.

⁵ *Ibid.*, 1919, xxiii, 334.

nuclei stain deeply; in the latter the large nuclei stain faintly. The former are typical of those nucleated red globules found in the hematopoietic organ of adults; the latter, of those found in the blood development of embryonic life. Megaloblasts may be found in non-idiopathic anemias. Grawitz regards the microcytes of importance as showing erythrocytic degeneration. There is usually a relative increase in the small lymphocytes at the expense of the polynuclear cells; and, according to Cabot, there was always a marked leukopenia in a series of 110 cases. Myelocytes are almost constantly present, though usually in low percentage. The average is about 2 per cent. The blood-plates are generally fewer than normal. The blood-plasma is markedly decreased (Adami). Cabot found that a blood examination made for the first time during the period of remission may resemble that in chlorosis, and in 9 of 14 cases ring-like bodies were seen in the red cells. There is a decrease in rouleaux-forming power, due to some change in the corpuscles. The blood volume is decreased. Whereas normally this is about 9 per cent. of the body weight in pernicious anemia, it may vary, according to a series of cases reported by Lindeman,¹ from 2.4 to 5 per cent.

Fig. 37.—Blood-chart of a case of progressive pernicious anemia. Black, red corpuscles; red, hemoglobin.

Diagnosis and Differential Diagnosis.—The clinical characteristics of the affection, particularly their steady progression with remissions, are quite as important as microscopic study of the blood. An important blood feature of the disease is a high color index. Wilbur and Addis² have shown that increase of urobilin in the stools is a valuable diagnostic aid, particularly in estimating the extent of hemolysis. More recently Schneider,³ by withdrawing bile with the duodenal tube and estimating urobilin in it, has offered a technically less difficult method of estimating the urobilin.

The possibility of hidden carcinoma, gastric atrophy, the ankylostoma or other parasite, and incipient tuberculosis should be borne in mind. *Intestinal parasites* are recognized from the microscopic examination of the feces after a brisk purge when their eggs or the parasites themselves may be found. *Atrophic gastritis* may be discriminated by examining the viscous and gastric juice by modern methods. The following table will permit the elimination of obscure gastric carcinoma as a rule:

¹ *Jour. Amer. Med. Assoc.*, 1918, lxx, 1291.

² *Arch. Int. Med.*, 1914, xiii, 235.

³ *Ibid.*, 1916, xvii, 32.

PROGRESSIVE PERNICIOUS ANEMIA

The blood shows characteristic changes, and the red corpuscle count falls to or below 1,000,000 per cubic millimeter.

Color index relatively high.

Leukopenia and relative lymphocytosis common.

Found earlier in life.

Gastric symptoms not so prominent.

Lemon-tinted skin common.

Adipose tissue fairly well preserved.

No glandular enlargements palpable.

No physical signs over stomach.

Free hydrochloric and lactic acids usually absent.

Some improvement may be brought about—even cure, though very rarely.

May show retinal hemorrhages.

Excess of urobilin in stools.

OBSCURE GASTRIC CARCINOMA

Blood shows characteristics of secondary anemia, and the count does not fall to 1,000,000, as a rule.

Color index low.

There may be leukocytosis or a relative increase in the polynuclear cells.

Occurs after middle life.

Gastric symptoms more suggestive.

Skin of a pale, muddy color, or only slightly jaundiced (saffron yellow).

Progressive emaciation.

Supraclavicular or inguinal glands may be palpable.

There may be an area of increased resistance over the stomach.

Examination of gastric contents shows deficiency or absence of free hydrochloric acid and presence of lactic acid.

Condition becomes steadily worse until death ends the case.

Absent.

Not marked.

From *chlorosis* the affection may be differentiated easily by the blood examination. The relative increase in hemoglobin, the presence of giantoblasts and many macrocytes, and the severe oligocythemia are pathognomonic of pernicious anemia, and are in marked contrast to the oligochromemia, and slight, if any, reduction in the number of red globules of chlorosis. Again, the progressive pernicious character of the former and the tendency to hemorrhage should be remembered, as well as the contrasting factors of age and sex in the two affections. Talley states that anemia secondary to portal cirrhosis without hemorrhage occasionally resembles progressive pernicious anemia. Pepper¹ calls attention to the fact that the severe anemia of chronic malaria may simulate to a marked degree pernicious anemia. Posterolateral sclerosis may be simulated, but the blood examination will usually show characteristic indications of pernicious anemia.

Prognosis.—The disease, as a rule, terminates fatally. The course of pernicious anemia is usually slow and gradual, and may be interrupted by improvement or apparent recovery. Recurrences, however, invariably occur. Idiopathic anemia is, therefore, almost hopeless, although a few apparently substantial recoveries have been reported. The duration of the disease is frequently prolonged; intermissions may last indefinitely and are prone to occur and to persist after splenectomy. Stockton² reports a case in which a remission of ten to twelve years occurred in which the only symptom present was the characteristic achylia gastrica. The nucleated red corpuscles usually become much more numerous shortly before death (Billings). In the last days of life the blood-picture of acute myeloblastic leukemia with extraordinary numbers of nucleated red cells has been observed. Death may be caused either by syncope, cerebral hemorrhage, or by slow asthenia.

Treatment.—**Hygienic measures** must be regarded as of signal importance, and rest in bed, together with light nutritious food given at short regular intervals, is indicated first of all. Klemperer advises a fatty diet—1 liter of cream and 200 grams of butter per diem. Lindeman³ advises the ingestion of 2 quarts of milk a day in order to increase the blood volume.

¹ *Amer. Jour. Med. Sci.*, 1918, clv, 70.

² *Ibid.*, 1919, clviii, 471.

³ *Jour. Amer. Med. Assoc.*, 1918, lxx, 1292.

one agglutinates the other. In this way, if the test is negative, hemolysis or agglutination will not take place after or during transfusion.¹ Vincent² has devised a rapid macroscopic method for testing blood groups which is "simple, rapid, and sufficiently accurate for practical purposes." Bearing in mind that there are four blood groups, which so act the one upon the other that agglutination of the corpuscles may take place if the serum of one or another group is added to the corpuscles of still a different group, it is possible to determine the group of an individual if the sera of two groups—II and III—are to be had. The test is performed as follows: A drop of Serum II and of Serum III is placed upon a glass slide with a small glass rod; a drop of blood is then mixed with each of the sera, care being taken not to mix the sera with each other. The slide is then rocked gently back and forth and in a minute or two agglutination, if it is to occur, will take place. This is shown by the appearance, in the agglutinated drop, of a minute reddish brick-dust sediment lying in clear fluid. The unagglutinated drops present a turbid homogeneous appearance. If the reaction is positive with Serum II, the person tested belongs to Group III; if positive with Serum III, to Group II; if positive with both, to Group I; and if negative with both, to Group IV. The importance of this lies in the fact that in selecting a donor for transfusion, if possible, he should be of the same blood group as the recipient. If this cannot be accomplished, a Group IV individual may be used as a donor for members of all groups. On the other hand, a Group I individual can be used as a donor only for a person in that group, whereas a Group II or III recipient can be transfused with blood from a member of his own group or Group IV and a Group IV individual only can receive blood from a Group IV donor. The frequency of the several groups is as follows: Group I, 5-8 per cent.; Group II, 40 per cent.; Group III, 7-10 per cent.; and group IV., 42-45 per cent.

Splenectomy.—The latest treatment of pernicious anemia is by splenectomy. The rationale of this treatment is not known. Eppinger believed that the spleen was capable of causing external hemolysis in pernicious anemia. Pearce and his collaborators have shown that splenectomy causes increased resistance of the red cells to salt solution. Whatever the effect, splenectomy at least offers a method of treatment which in selected cases affords a longer period of remission of the disease than any other method of treatment. Says Mayo³: "From our experience with 19 cases, I feel justified in performing splenectomy in selected cases." Krumbhaar studied 152 cases, of which 19.6 per cent. died, 64.7 per cent. showed distinct improvement in the clinical condition and in the blood-picture, while 15.7 per cent. showed no improvement. The most favorable results are to be expected in the earlier stages and in individuals with enlarged spleens. McClure advocates transfusion, sometimes repeatedly, both before and after splenectomy.

The most recent publication from the Mayo Clinic is by Giffin,⁴ who reports 31 cases treated by splenectomy. He summarizes his paper in part as follows: There is no evidence that splenectomy has cured pernicious anemia; in the 31 cases there was definite improvement in 78 per cent. of them three months after operation; 68 per cent., six months after operation; the operation is advisable in young and middle-aged patients who show evidence of active hemolysis (urobilin excretion in excess) and a moderately enlarged spleen; pre-operative treatment, especially by repeated transfusions, is indicated to bring hemoglobin up to 35 per cent., and red cells over 1,500,000, if possible. In the 4 cases of splenectomy in pernicious anemia that have come under the

¹ Rous and Turner, *Jour. Amer. Med. Assoc.*, 1915, lxiv, 1980.

² *Jour. Amer. Med. Assoc.*, 1918, lxx, 1219.

³ *Ibid.*, March 4, 1916, p. 721.

⁴ *Ibid.*, 1917, xviii, 429.

observation of the authors, one patient died shortly after the operation, the other three were markedly benefited.

Anthelmintics must be used in those cases of pernicious anemia in which intestinal parasites are associated. Dilute hydrochloric acid must be used in large doses before and after meals on account of the associated achlorhydria, and bitter tonics are serviceable in cases in which digestion is impaired. The eradication of foci of infection, according to Bloomfield,¹ is of value for its general beneficial effects, but has no direct effect on the genesis of the disorder.

Recurrences will yield to the same treatment, if they yield at all.

APLASTIC ANEMIA

Definition.—This is a “type of anemia differing in many respects from ordinary types of primary or secondary anemia, but marked especially by retrogressive changes in the bone-marrow which result in a change in the normal red marrow to a fatty marrow” (Musser²). It would seem that aplastic anemia is an anemia secondary to marrow changes which are dependent upon some known (benzol) or unknown cause.

Schneider,³ in view of the evidence of toxic marrow destruction, would prefer to call aplastic anemia toxic paralytic anemia or toxic anhemopoietic anemia.

The disease runs a rapid course to a fatal termination in a few weeks to one or two months. In addition to the usual symptoms of anemia there is a pronounced tendency to subcutaneous hemorrhages and hemorrhages from mucous membranes. The blood-picture shows an intense anemia of the erythrocytes and hemoglobin, with an irregular color index. There is a pronounced leukopenia, with an absolute decrease in the granular leukocytes and a relative increase in the lymphocytes. The morphology of the red cells is changed but little from the normal. There are no blast cells found and the reticulated forms are absent. Polychromatophilia is not found.

HEMOLYTIC ANEMIA OF PREGNANCY AND PUERPERIUM

Definition.—This is a type of anemia, apparently causeless, which develops in the latter part of pregnancy or the early puerperium. The *pathogenesis* of the condition is obscure, though inferentially some toxin of pregnancy is presumed to produce the condition. The pathology is much the same as that of pernicious anemia.

The **course** is very rapid. If the patient does not die in a few days or weeks recovery follows. Though usually considered as a disorder likely to terminate in death, Osler⁴ considers the prognosis quite favorable. The symptoms are those of any anemia plus the rapid reduction in the number of red cells. There is also noted a slight leukocytosis, with a relative and absolute increase in the lymphocytes, normoblasts, bilirubinemia, and urobilinuria. The treatment is to terminate pregnancy if the anemia is rapidly progressing and if the patient has not already been delivered. There is a very definite indication also for prompt and repeated transfusions. In addition to these two measures the usual treatment of any anemia should apply.

HEMOLYTIC JAUNDICE

(*Chronic Family Jaundice; Hemolytic Splenomegaly*)

Definition.—A chronic type of anemia characterized by persistent non-obstructive jaundice, splenomegaly, and decreased resistance of the red cells by hypotonic salt solution.

¹ *Bull. Johns Hopkins Hosp.*, 1918, xxix, 101.

² *Arch. Int. Med.*, 1914, xiv, 275.

³ *Amer. Jour. Med. Sci.*, 1918, clvi, 799.

⁴ *Brit. Med. Jour.*, Jan., 1919, p. 1.

Pathology.—Krumbhaar¹ says that the spleen is enlarged,* there is increased congestion in the pulp and sinuses, increased pigment, and an increase in phagocytes of spleen, seen microscopically. There is a deposition of blood-pigment also in the liver, kidneys, and bone-marrow.

Pathogenesis.—There has been an enormous amount of work and much theorizing concerning the cause and mechanism of production of hemolytic jaundice. Two types of the disorder are recognized, a congenital or familial type and an acquired type. The former is supposed to be due to a primary inherited dystrophy of the red cells or else to a primary increased hemolytic activity of the spleen, the latter to possibly some infection as malaria, syphilis, etc. As a result of the increased blood destruction there is an excess of bile formed in the liver which fills the bile capillaries and is resorbed into the blood. The increase in the size of the spleen might be attributed to the increased blood destruction.

Symptoms.—The two types, in general, resemble one another closely in their symptoms. Chronic jaundice, without the usual associated symptoms (bile in the urine, itching of the skin, etc.), and which is extremely irregular in its intensity, at times almost disappearing and then returning in marked exacerbations, is the most characteristic symptom. Associated with the subicterus there is an anemia, chlorotic in type, which fluctuates in severity in direct relation to the severity of the jaundice. The blood also shows marked diminished resistance of the red cells, a finding which is almost pathognomonic of the condition, and there is an excessive urobilin output as an indication of the increase of blood destruction. The spleen is enlarged. The familial form is mild and usually the patient considers his trouble a cosmetic disturbance rather than an evidence of illness. In the acquired form the anemia is usually much more grave and the jaundice more marked. The hemolytic crises are more frequent and more severe, often being accompanied by sharp pain in the region of the liver and spleen and by a rise in temperature. Both types of disease are essentially chronic in their course, but in the acquired form the anemia may become so severe as to resemble pernicious anemia, during which time the patient may die from some intercurrent infection.

Treatment.—Splenectomy is the only known measure that will cure. It has been suggested that in these cases where the disease is not sufficiently severe to warrant operation, the Roentgen ray might be utilized to reduce the hyperfunctioning (?) of the spleen. Loeper² reports favorable results from arsphenamine.

BANTT'S DISEASE

(Splenic Anemia; Primary Splenomegaly with Anemia)

Definition.—A form of anemia associated with great increase in size of the spleen, a tendency to hemorrhages, and, in its later stages, cirrhosis of the liver.

Pathology.—Among pathologic characters splenic enlargement is to be especially noted. It is an idiopathic enlargement of the spleen with anemia and without lymphatic involvement. The splenic veins are enormously enlarged and when the blood is drained off the spleen "becomes a flabby elastic mass" (MacCallum). There is a moderate atrophy and scarring of the malpighian bodies, and the veins are separated by loose fibrous tissue in which but few of the original pulp cells remain. The bone-marrow responds to the anemia by a more or less inadequate hyperplasia (Krumbhaar). The liver is often cirrhotic.

Pathogenesis.—An enormous amount of work has been done on Banti's disease in the last few years, but nothing has been definitely accomplished

¹ *Amer. Jour. Med. Sci.*, 1915, cl, 227.

² *Progrès méd.*, 1919, xxxiv, 223.

in determining the pathogenesis of the disorder. The one outstanding fact is that, as splenectomy will cure in the early stages, the disease is due to some alteration of the spleen. Gibson attributes this change in the spleen to the presence of a streptothrix in the pulp; Yates and his co-workers have found diphtheroid bacilli in the spleen; Goldman has produced a syndrome resembling Banti's disease by causing thrombosis of the splenic vein; Hollins, by injections of *Bacillus coli*. Banti now ascribes to the view that the hypothetical toxin either acts directly on the spleen or is some substance which is changed by splenic metabolism into a splenotoxin. Krull believes that the disease is an unusual form of the atrophic cirrhosis of Laennec, the frequent vomiting of blood accounting for the anemia. Norris, Symmers, and Shapiro¹ believe Banti's disease to be a manifestation of visceral syphilis and not an independent clinical or anatomic entity.

Symptoms.—The affection is characterized by three stages: (1) Preascitic stage, lasting several years, in which there is a perceptible and gradually increasing anemia and weakness, associated with vague digestive disturbances and pain at times in the region of the spleen, which is found to be enlarged, smooth, and hard. The anemia is of the chlorotic type and is not particularly pronounced. Nucleated reds are absent, but there is excessive urobilin elimination to show that there is excessive erythrocytolysis, though less marked than in hemolytic jaundice or pernicious anemia. A tendency to hemorrhage, particularly gastric, is noted. There is a moderate leukopenia. (2) The intermediate stage is often difficult to separate from the first and last stages. Increase in the size of the liver, painless diarrhea, scanty high-colored urine characterizes this state. (3) The ascitic stage is characterized by the symptoms of hepatic cirrhosis: recurrent pronounced ascites, a shrunken liver, greatly enlarged spleen, and marked secondary anemia exaggerated by the tendency to gastric hemorrhage are found. The anemia increases rapidly, marked asthenia develops, and in a few years the patient dies as a result of the progressive asthenia or as a result of hemorrhage.

Treatment.—The specific treatment is removal of the spleen. If done in the early stage a cure will result. Following this there is observed a well-marked increase in resistance of the red cell to hypotonic salt solution. Later, splenectomy will sometimes prolong life, but will not cure. Treatment in the late stages follows the same general plan as outlined for pernicious anemia, with recourse to paracentesis when the abdominal fluid causes pronounced distress.

LARGE-CELL SPLENOMEGALY

(*Gaucher's Disease*)

Brill and Mandlebaum² have recently called attention to Gaucher's disease, which they believe to be a pathologic and clinical entity. They point out that the pathologic feature of the disease is the presence in the spleen, liver, lymph-nodes, and bone-marrow of distinctive large cells, with characteristic cytoplasm and small nuclei. Knox, Wahl, and Schmeisser report 2 cases in infancy.

It is characterized clinically by an enormous enlargement of the spleen and liver; the brownish-yellow discoloration (non-icteric) of the skin; the conjunctival thickening; the long duration of the disease; its predilection for females; its familial occurrence; the feeling of comfort and ease, notwithstanding the tremendous protrusion of the lower thorax and abdomen; the tendency to hemorrhage, manifested by epistaxis and bleeding from the gums; the

¹ *Amer. Jour. Med. Sci.*, December, 1917, p. 893.

² *Ibid.*, 1913, p. 863. .

ecchymoses in the skin; the persistent leukopenia; the mild degree of chlorotic anemia without changes in the red cells; the absence of jaundice and ascites; the absence of palpable lymph-nodes, making a symptom complex which differentiates this disease from Banti's disease, with which it is most likely to be confounded. The *treatment* is similar to that of splenic anemia.

II. THE SECONDARY ANEMIAS

The secondary anemias are symptomatic of abnormal processes or of existing disease, whether acute or chronic, and their causes are numerous and various. Several possible causes may exist in a given case of symptomatic anemia, and it may be quite difficult to discover which of these is the active factor in the condition. In certain secondary anemias, also, the associated impairment of the blood-making organs is so evident that the anemia may assume almost a primary importance.

THE BLOOD.—There is *oligocythemia*, usually of a moderate degree, about 3,000,000 red corpuscles per cubic millimeter being noted, although in cases following hemorrhage the reduction may be as great for a time as in pernicious anemia. There is also a relative decrease in the amount of *hemoglobin*, and sometimes the percentage may be relatively lower even than is compatible with the decrease of the red corpuscles. Early evidences of secondary anemia are alterations in the viscosity of the red cells and failure to form rouleaux and an unequal distribution of the hemoglobin, certain cells being overcharged, while others are inadequately supplied. Next in the process of degeneration of the red cell is irregularity in size and shape (microcytes, macrocytes, poikilocytes), and third, is abnormal staining reactions (polychromatophilia, punctate basophilia). Lastly, there appear abnormally large nucleated red cells (megaloblasts). Normoblasts are also present in severe cases. There is a relative, and often an absolute, increase in the number of *leukocytes*. The plasma chlorids are definitely more concentrated in experimental anemia than in control animals (Steinfeld¹).

The most important etiologic groups of secondary anemias are as follows: (1) **Hemorrhage.**—Hemorrhages occur under a great variety of circumstances, and if copious, result in an acute secondary anemia. Thus there may be the rupture of an aneurysm, menorrhagia, postpartum hemorrhage, hemoptysis, gastrorrhagia, enterorrhagia, etc., all of which produce the same general effect upon the system. Repeated small hemorrhages may finally produce the same result as a single large one, and spontaneous hemorrhages or epistaxis, such as occur in persons of a hemorrhagic diathesis (hemophilia) or in purpura and scurvy, may cause profound secondary anemia. Females are more tolerant of losses of blood, but infants of both sexes bear depletion very badly. The total mass of blood may be much diminished, and the sudden loss of a great volume of blood may prove fatal in a few moments; but it is often surprising how recovery can take place, and often does, after the rapid loss of several pounds of blood—*e. g.*, in hemoptysis, hematemesis, or menorrhagia. Sometimes the source of bleeding is obscure, as in cases of intestinal parasites, hepatic cirrhosis, or duodenal ulcer; or it may be intentionally kept *sub rosa* by females having uterine disorder or bleeding hemorrhoids. The quick blanching of the countenance, the weakness, the coldness of the skin, faintness, dimness of vision, tinnitus aurium, sighing respiration, and feeble, rapid pulse are characteristic symptoms of *acute anemia*. *Unconsciousness* and *epileptiform convulsions* precede death in cases in which the total volume of blood lost

¹ *Arch. Int. Med.*, 1919, xxiii, 511.

is sufficiently large. When *recovery* takes place the blood regeneration goes on rapidly, so that within from one to three weeks restitution is complete. The normal volume is soon restored—first by the absorption of water, hydremia, existing for several days before the saline and albuminous elements are renewed. The white corpuscles are earlier restored than the red, so that there is a temporary relative leukocytosis. The hemoglobin is restored still more slowly than the red corpuscles.

Fig. 39.—Blood-chart of a case of symptomatic anemia. Black, red corpuscles; red, hemoglobin; blue, white corpuscles.

(2) **Inanition.**—Anemia from inanition may be caused by a food supply that is insufficient either in quantity or quality, or both; or even with abundant food of sufficient nutritive qualities the digestive power may be so impaired as to cause defective assimilation. Esophageal carcinoma and chronic gastritis, especially of the atrophic variety, may thus cause anemia from inanition. The reduction of the blood-plasma forms a feature, while the corpuscles may be affected but slightly.

(3) **Excessive albuminous discharges**, as in chronic Bright's disease, prolonged suppuration, long-continued lactation, chronic dysentery, etc., drain the system so that marked anemia may be produced.

(4) **Toxic Agents.**—The poisons may either be organic or inorganic, though toxic anemias are most common from the absorption of lead, arsenic, mercury, and phosphorus. The poisoning is usually chronic, and affects principally the corpuscles, but may affect the marrow (benzol, osteosclerosis, etc.). Anemia due to the poisons of acute or chronic infectious diseases is also fre-

ecchymoses in the skin; the persistent leukopenia; the mild degree of chlorotic anemia without changes in the red cells; the absence of jaundice and ascites; the absence of palpable lymph-nodes, making a symptom complex which differentiates this disease from Banti's disease, with which it is most likely to be confounded. The *treatment* is similar to that of splenic anemia.

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¹ *Arch. Int. Med.*, 1919, xxiii, 511.

quently met with, and may thus be observed during and after typhoid fever, diphtheria, yellow fever, and inflammatory (articular) rheumatism among the acute diseases, and during chronic malaria, tuberculosis, and syphilis ("syphilitic chlorosis"). There is considerable destruction of the red corpuscles in some of these diseases, either directly or indirectly, and the greater the pyrexia, the greater the action upon the blood or blood-making organs.

Symptoms.—The *common indications* of secondary anemia are the pallor of the face and mucosæ, muscular and mental weakness, loss of nerve function, neuralgias, coolness of the skin, dyspnea on exertion, cardiac palpitation, impaired appetite and digestion, and a weak pulse. The physical signs are those of the primary or essential anemias.

Diagnosis.—Here may be advantageously contrasted the distinguishing features of symptomatic and essential anemias, respectively:

SYMPTOMATIC OR SECONDARY ANEMIA

A symptomatic blood condition secondary to a detectable disease elsewhere.

Occurs at any age.

Previous or associated history of traumatic or spontaneous hemorrhage, chronic suppuration, prolonged lactation, chronic Bright's disease, carcinoma, chronic lead-poisoning, chronic malaria, heart, liver, or gastric trouble. Blood changes not so marked and more variable; steadily progressive in malignant disease.

Moderate reduction in both, merely the relative proportion being maintained.

General symptoms and signs usually subordinate in manifestation to those of the primary disease or lesion.

Gravity of anemia depends on that of the primary disease.

Often responds to treatment, depending on the cause; in a few instances, as in hemorrhage, it is short in duration.

IDIOPATHIC OR ESSENTIAL ANEMIA

A primary disease of the blood and blood-making organs.

Occurs principally during adolescence and early middle life.

Previous history negative in its bearings upon the disease.

Distinctive blood characteristics, and often profound changes, both as to blood-cells and hemoglobin.

Marked reduction in both the hemoglobin percentage and in the number of red corpuscles, but the proportionate ratio is lost.

General symptoms and signs also more characteristic of the respective form of anemia in the case.

Depends on type of blood changes and progressiveness of disease.

One variety (chlorotic) quite curable, the other (progressive pernicious) relapsing, and finally fatal.

The **prognosis** depends upon the cause of the anemia.

Treatment.—Symptomatic anemia is amenable to treatment according to the cause. The traumatic acute variety does well under simple hygienic measures after the urgent indications have been met. Plenty of pure air, wholesome food, and graduated rest and exercise may suffice, and drugs not be needed. Cases in which it is difficult or wellnigh impossible to remove the cause of the anemia do not improve under any treatment, as a rule. Nutritious alimentation, iron in some form, a judicious hygienic regimen, and stomachic and general tonics are required in the majority of cases. In severe forms, hypodermic injections of iron and arsenic, in combination, act favorably. Salvarsan in small doses may be tried in intractable cases of secondary anemia (0.05 or 0.075 gm., for ten to fifteen injections). Toxic substances must be eliminated, their re-introduction into the body prevented, and the repair of the blood and tissue actively promoted.

Emsheimer advocates the employment of intramuscular injections of whole human blood before other radical measures in severe cases, the blood being withdrawn from the donor and immediately injected into the recipient. In any case of purpura with much blood loss it is advisable to give repeated (every one to three days) injections of blood rather than an overwhelming large dose.

HEMOPHILIA

(*Bleeders' Disease*)

Definition.—An hereditary affection, transmitted by females who are themselves not affected (Nasse's law). It is characterized by frequent uncontrollable hemorrhages that are either spontaneous or due to slight traumatism, and which are the result of failure of coagulation of the blood.

Etiology.—Hemophilia is more distinctly hereditary than any other known disease, but Nasse's law is not of such universal application as is supposed. R. Kolster found that of 50 hemophilic families, 18 cases followed this law, 16 others with some exceptions to its provisions, and 12 without any regard to it. The law embraces the following points: The daughter (not herself affected) of a bleeder transmits the tendency to her sons, who become bleeders; her daughters do not suffer, but, in turn, transmit the disease to their sons. Females, however, may be bleeders, and, according to Virchow, one woman is affected to every seven men. The disease has been traced for centuries in a few families.

It is observed in all classes of society, and is most frequent in families whose members are large, vigorous, and have delicate complexions, the complaint usually manifesting itself before the end of the second year of life, though exceptionally as late as puberty. An acquired hemorrhagic diathesis is seen occasionally in connection with certain acute infections and more commonly in the graver anemias (leukemia, pernicious anemia). The *pathogenesis* of the disorder has been variously attributed to: (1) a deficiency in calcium (proved incorrect); (2) an insufficiency of thrombokinase; (3) a hypothetic substance which inhibits coagulation; (4) an alteration in the properties of the circulating prothrombin; and (5) a deficiency in the amount of prothrombin in the blood.

Symptoms.—The occurrence of profuse and persistent bleedings that are either spontaneous or the result of slight injury characterizes hemophilia. The character of the injuries that lead to dangerous bleedings is often exceedingly trivial; thus a slight scratch, cut, blow, the extraction of a tooth, and other minor surgical operations (*e. g.*, circumcision) may be followed by severe hemorrhage.

If we include spontaneous hemorrhages, bleedings take place most frequently from the nose.

The capillaries ooze blood—a process that may vary in duration from a few hours to as many weeks. A fatal result may occur in a few hours, while, on the other hand, recovery may follow a slow oozing of blood that has continued for many days. In the latter instances profound anemia follows, the blood, however, being rapidly replaced. Extensive blood extravasations (hematomata) usually follow contusions. Petechiæ, when they occur, are apt to be spontaneous.

Arthritic symptoms are common, the larger joints, and especially the knees, being most frequently affected and showing swelling that is due chiefly to hemorrhages into the joints. In other instances febrile synovitis may be present, resembling rheumatism. The joint symptoms may either announce

HEMORRHAGIC DISEASES OF THE NEWBORN

(a) **Epidemic Hemoglobinuria (Winckel's Disease).**—This affection, which is *septic* in nature, is occasionally met with in lying-in hospitals, and occurs in children from one to ten days after birth. The infants refuse the breast and show hematogenous icterus; gastro-enteric catarrh is an attendant of the disease. The stools are meconic; the urine is scanty, dark colored (from methemoglobin), often albuminous, and may contain casts. Hemorrhages occur into organs other than the kidney and into the mucous membranes, there also being mild fever, rapid emaciation, and often mild convulsions. It is a very fatal disease. Bacteriologic experiments have shown that the disease may be produced by the growth of the colon bacillus in the buccal epithelium of infants. Kilham and Mercelis report an epidemic of 10 cases occurring in the New York Infirmary; complete bacteriologic studies were made in all, and the organism discovered suggested the diplococcus of pneumonia or the pneumococcus group. There is, however, great confusion in regard to the possible specific micro-organism of this disease.

(b) **Acute Fatty Degeneration of the Newborn (Buhl's Disease).**—This disease may be similar to Winckel's in nature. It was first described by Hecker and Buhl as an infectious disease of the newborn, characterized by cyanosis, jaundice, and copious visceral hemorrhages. The chief *pathologic change* is an acute fatty degeneration of the internal organs.

(c) **Syphilis Hæmorrhagica Neonatorum.**—Either at birth or soon thereafter bleedings take place into the skin (ecchymoses) and from the mucous surfaces and the navel. Jaundice may be associated. The viscera are found upon postmortem examination to be the seat of syphilitic lesions.

(d) **Morbus Maculosus Neonatorum.**—Hemorrhage from the gastrointestinal mucosa of the newborn (melæna neonatorum) occurs, and may be due to intracranial lesions during birth; it may also take place independently of the latter. Preuschen has collected the reports of 37 cases, in 5 of which the brain was examined, and all of these showed cerebral hemorrhages. The latter may occur in spontaneous births and give rise to melæna neonatorum. Gärtner believes the disease to be an infectious one, and claims that in 2 cases he was able to identify a bacillus for which the navel is believed to be the entrance point. The blood may also come from the mouth, nose, navel, etc. Townsend found morbus maculosus neonatorum in 45 cases in 6700 deliveries, and in most of these instances the bleeding was general. The hemorrhage usually sets in during the first week, rarely later, and the duration of the disease is between one and seven days, the mortality being a little over 50 per cent. Vomiting of the blood which the child has drawn from the breast must not be confounded with true melæna. The *treatment* is by injections of whole blood, citrated or fresh, blood-serum (antitoxin), or kephalin.

LEUKEMIA

(Leukocythemia)

Definition.—A blood disease, usually chronic, characterized by a peculiarly marked and persistent increase in the number of leukocytes, associated with lesions occurring either respectively or unitedly in the bone-marrow and lymphatic glands.

Pathology.—Bodily emaciation and pallor are pronounced, and edema, with dropsical effusions in the serous cavities, is by no means uncommon. The cardiac chambers and principal veins are distended with large blood-clots of a greenish-yellow or, in extreme cases, yellowish-white, purulent appearance. Subserous ecchymoses of the pericardium and endocardium are

show enlargement, paleness, and diffuse and circumscribed leukemic infiltration of the capillaries and interlobular tissue. Leukemic nodules may also be found in other parts of the body—retina, brain, serous membranes, lungs, testicles, and skin. Karyokinetic figures are numerous in the cells accompanying these leukemic growths.

Pathogenesis.—The primary cause of leukemia is unknown; that it directly affects the blood-forming organs, however, is most probable, though with differences of selection and co-ordination and with different degrees of intensity. The combination of lesions in the spleen, lymph-glands, and bone-marrow, along with the histologic similarity of the leukemic growths to the infectious granulomata, and the clinical history of cases of acute leukemia, would seem to point strongly to the *microbic origin* of the disease. Moreover, various cocci and bacilli have been found, and Hausemann finds much to sustain the hypothesis that the tonsils are generally the seat of the infectious process. Ellerman has transmitted chicken leukemia, the virus of which is filterable. Schmeisser¹ has confirmed and extended this work, reporting the transmission of myeloid leukemia from organ extracts of a chicken suffering from this disorder, so that the blood-picture resembled that of the disease as seen in man in the fourth generation of the fowls. Dias concludes that leukemia of the myeloid type is the work of a fungus (*Adenomyces leukemiae*). Some observers contend that there is a very direct relationship to tuberculosis, but in all likelihood the occasional occurrence of tuberculosis and leukemia in the same individual is merely a coincidence and without any bearing on the genesis of the condition. On the contrary, it would seem more likely that the leukemia was a predisposing element in the causation of the tuberculosis than tuberculosis in leukemia. The other important theory as to the genesis of the disease is that it is neoplastic in nature. The blood in this condition has been likened to a circulating sarcoma. Symmers² says that chronic lymphatic leukemia represents "an automonous process due to a self-perpetuating lymphotoxin origin, that it belongs to the category of lymphosarcomas."

Etiology.—Leukemia occurs most frequently in males during the middle period of life, and is apt to attack young persons. It has occurred during infancy, and as late also as the seventieth year, but the average ranges age from twenty-five to forty-five years. Sometimes the previous condition was one of apparently perfect health.

Symptoms.—**Acute leukemia**³ comparatively rare, usually occurs in an adolescent who may have enjoyed previous good health. Fussel and Taylor collected 56 cases from the literature. Hamman tabulated 111 cases, and in several affections of the mouth or throat were observed at the commencement. Acute lymphoid leukemia is more common in children than has been supposed, Sluka,² in 1907, having collected 55 cases. Its onset is sudden, and usually begins with prostration, hemorrhage of the mucous membranes, and high fever. Acute splenic tumor rapidly develops; the lymphatic glands may enlarge; and palpitation, dyspnea, and gastro-intestinal symptoms of a severe type appear. The skin become anemic, and edema of the feet is common. The blood shows a marked increase in the number of leukocytes, the ratio to the red corpuscles being 1 to 30 or 1 to 50, instead of the normal—1 to 350 or 1 to 600. In *acute lymphoid leukemia* the lymphocytes are very numerous. In *acute myeloid leukemia* there is an increase in the blood of a cell originating from the myelocytic cells of the bone-marrow, representing the ancestor of the myelocytes and granular leukocytes, which are numerous

¹ *Jour. Exp. Med.*, December, 1915.

² *Arch. Int. Med.*, 1918, xxi, 237.

³ Quoted by Brinckmann, *Norsk Magazin for Lægevidenskaben*, Christiana, December, 1915.

while the surface is smooth and the consistence firm. A friction-fremitus is felt sometimes during respiratory movement. The tumor may vary in size, and after hemorrhage or diarrhea it may become swollen. Gastric distress after eating and obstructive constipation are usually complained of in cases of great splenic enlargement. Jaundice may also be present. Pulsation has been noted and a systolic murmur—"splenic souffle"—has been heard at times over the tumor. The percussion-note is dull over the tumor, and areas of movable dullness, due to fluid occupying the peritoneal cavity, are not infrequent. A wave of fluctuation may be detected over the abdomen. The liver is often enlarged.

Lymphatic Glands.—These are often enlarged in connection with the myeloid variety, and in the rarer lymphoid leukemia the superficial lymph-glands may be both visibly and palpably enlarged, though not in bunches as in Hodgkin's disease. They are soft, resilient, and movable.

Fig. 40.—Blood-tracing of a case of leukemia. Black, red corpuscles; red, hemoglobin; blue, white corpuscles.

The Bones.—Purely myelogenous leukemia is very rare, and local bone symptoms are scarcely ever manifested. There may be some tenderness on immediate percussion over the sternum or some of the long bones, and slight swelling, irregularity, or deformity of the ribs, the sternum, or other bones may result from leukemic hyperplasia.

The Blood.—It is by the blood examination alone that the pathognomonic features of leukemia are determined. The blood is paler than normal, and sometimes has a brownish-red or chocolate color. Upon a microscopic examination of the blood in the myeloid form of the affection the striking increase in the number of leukocytes is observed at once. The count shows usually from 85,000 to 500,000 white corpuscles per cubic millimeter, and the ratio of the white to the red cells may thus vary from 1 to 150 down to 1 to 10 or 1 to 5 in the average case, instead of the normal—1 to 500 (Fig. 40). In extreme cases the number of leukocytes may be equal to, or even slightly greater than, that

Diagnosis.—This can be made accurately by the blood examination alone, the distinguishing characteristics of the blood having been enumerated above, both as to the existence of leukemia and the differentiation of its several varieties. Stained specimens of the blood should be studied, since the excess of leukocytes is not proof of leukemia, and also because the disease may exist without an excess (*e. g.*, the lymphoid variety), owing either to previous treatment or to temporary improvement.

Differential Diagnosis.—Leukemia is differentiated from a marked *leukocytosis* by the fact that in the latter there is usually a more moderate increase in the number of leukocytes, affecting, as a rule, principally the polynuclear neutrophils; in addition, myelocytes are absent.

Hodgkin's disease may be simulated by the purely lymphatic leukemia on account of the enlarged glands; but in leukemia the lymph-glands are not found in such large bunches, and the blood examination will show the characteristic changes of lymphatic leukemia if the disease be present. Simply a leukocytosis is present in pseudoleukemia.

Malignant growths of the spleen and lymphatic glands, and also a malarial and passively congested spleen with anemia, may simulate leukemia. Here again the blood examination will exclude leukemia.

Prognosis.—Many cases are mild in their progress; children, however, when affected succumb more rapidly than do adults. Lymphatic leukemia is always fatal earlier than the splenomedullary variety, and in severe acute cases the larger lymphocytes are found. Although recovery does occur occasionally, most cases of leukemia, of whatever form, prove fatal certainly within five years, generally in two or three years, and sometimes in seven or eight months or even less (from two weeks to two or more months) in acute leukemia. In an advanced case the prognosis is hopeless. Grave symptoms heralding an early termination are profound debility, anemia, severe hemorrhages, cerebral apoplexy, persistent diarrhea, and high fever. Intercurrent affections not infrequently cause death, while, on the other hand, cases are recorded in which the appearance of intercurrent infectious diseases (erysipelas, enterocolitis, pleuritis) has favorably affected the course of leukemia. Pregnancy exerts an unfavorable influence. Remissions may rarely occur.

Treatment.—At present no remedies are known to have any permanent curative effect. The application of the roentgen ray over the spleen and the long bones (viscera ten-minute exposures, applications being made only over one extremity at a time or over the spleen), at first suggested by N. Senn, is followed by: disappearance of the fever; decided decrease in the volume of the spleen; increase in the number of red cells and hemoglobin. The leukocytes are at first materially reduced, but later the blood again becomes leukemic. Oettinger, Fiessinger, and Sauphar¹ claim that radiotherapy produces a leukolytic ferment, which, by disintegrating the corpuscles, may transform chronic myeloid leukemia into an acute phase, or pernicious anemia. Warthin believes that the roentgen ray treatment of leukemia finds a pathologic basis in the selective action which the rays have for cells of the lymphocytic and myelocytic types. Based upon the work of Selling, who showed that benzol is a leukotoxin, Korányi applied the drug to the treatment of leukemia in 1912. Since then many reports have followed upon the results of this line of treatment, and as a consequence of these reports the early enthusiasm has markedly fallen off. Miller² relates, for example, that 20 of 24 patients of which he has knowledge, who were treated by benzol and Roentgen rays, have died within three years of the institution of the treatment. However, the

¹ *Arch. des maladies du cœur*, etc., Paris, May, 1910; *Jour. Amer. Med. Assoc.*, June 11, 1910, p. 2006.

² *Handbook of Practical Treatment*, Phila., 1917, vol. iv, p. 450.

results, though temporary, are better than any form of treatment yet employed. More recently, Vaquez and Yacoel report 3 cases and tabulate reports from 11 other clinicians, all showing improvement in general health and reduction in the size of the spleen and in the number of leukocytes, while the erythrocytes were increased. It is in the early phase of leukemia that benzol produces its finest effect. The remedy should be discontinued when the leukocyte count is reduced to 20,000. Barker and Gibbes believe that for the present its use should be restricted to the treatment of patients in hospitals. The use of benzene should be combined with the Roentgen ray treatment in all cases unless nephritis be present. Ordway¹ states that radium treatment, although not to be regarded as curative, is the best form of therapy now at our disposal.

The environment should be made as favorable as possible—physically, mentally, socially, and morally. Out-of-door life in a mild, dry climate, an abundance of nutritious and easily digestible and assimilable food, calm and moderate exercise of mind should all be advised and encouraged. On the other hand, traumatism, irregular habits of body, worry, excitement, and passionate appetites should be regulated and avoided.

Arsenic gives the best results in most cases, and should be pushed to the limit of tolerance, as in pernicious anemia. It should be given continuously, regardless of apparent improvement under its use, as the latter may be only the natural remission—a not uncommon incident in the disease. Complications may be relieved by appropriate treatment.

LEUKANEMIA

So-called "leukanemia" (Leube) is most probably either leukemia with terminal anemia, or pernicious anemia with lymphoid or myeloid marrow (Cabot).

LEUKOSARCOMA

Under this broad heading may be classified the atypical case of leukemia associated with tumor formation. It includes the localized hyperplasia of the lymphoid tissue, termed "chloroleukosarcoma" or "chloroma," and hyperplasia of the myeloid tissue, "chloromyelosarcoma" (myeloid chloroma).² These tumors are composed of lymphoid or myeloid cells which escape into the blood and give the characteristic leukemic blood-picture. Various types of these tumors have been reported, as, for example, the mediastinal leukosarcomatosis in which the tumor apparently grows from the remains of the thymus gland.

The most frequent type of such tumor is the one designated broadly as chloroma on account of the green pigment contained in it, and which may be composed of either type of cell. As Weber says, these should be considered as cases of leukosarcoma to which there is added the additional factor of the greenish color, and which is not a sufficient basis for the separation of these cases from other similar leukosarcomatous new growths without pigment.

The lymphoid chloroma is the type most frequently seen and arises usually in connection with the periosteum in the bones of the head and face.

Symptoms.—Pain in the orbital region, exophthalmos, and deafness are noted early. The principal diagnostic features are gangrenous stomatitis and often a high-grade anemia, usually associated with a hemorrhagic diathesis. There is some enlargement of the lymphatic glands and spleen. In the lymphoid form there occur the tumor-like infiltrations of the orbit and other parts of the skull, and it is seen in children. The blood-picture is that of lymphoid leukemia. The myeloid form is characterized by the presence of neutrophilic

¹ *Boston Med. and Surg. Jour.*, 1917, clxxvi, 490.

² MacCallum, *Textbook of Path.*, Phila., 1916, p. 76; Weber and Wolf, *Amer. Jour. Med. Sci.*, August, 1916, p. 231.

myelocytes, making up from 50 to 95 per cent. of the cells, and a marked leukocytosis. It seldom shows tumor growths. In those cases in which the tumor formation is not prominent, the clinical picture may resemble pernicious anemia, acute sepsis, scorbutus, or a septic diphtheria (Bierring).

The *course* of the disease—spoken of by French writers as “green cancer”—is rapid, and death usually comes on within a few months. The roentgen rays have given marked improvement in the *treatment* in some cases, but not in others.

LEUKOSARCOMATOSIS

This is a mediastinal leukosarcomatosis, so named by Carl Sternberg, occurring in young persons, in which there is a leukemic blood-picture and in which the mediastinal tumor (sarcomatous) appears to be growing from the remains of the thymus gland. The condition is similar to chlorosarcomatosis, although lacking the greenish pigment from which chloroma derives its name. Weber and Wolf¹ report a case of the kind in which the growth was “molded over the parietal pericardium, covering it like a blanket.”

HODGKIN'S DISEASE

(*Pseudoleukemia; General Lymphadenoma*)

Definition.—An anemia characterized by the anatomic peculiarities resembling those of lymphatic leukemia—viz., progressive hyperplasia of the lymph-glands, occasional secondary lymphoid growths of other organs (liver, spleen); and by the absence of the destructive blood changes of true leukemia.

Varieties.—Although the disease that bears his name was first described by Hodgkin of Guy's Hospital in 1832 as an affection of the lymphatic glands and spleen, two varieties are included under the title of pseudoleukemia (or Hodgkin's disease), as follows: (1) that which presents simply an enlarged spleen (the less frequent one); and (2) that in which the lymphatic glands are chiefly involved.

Pathology.—The lymph-glands show different degrees of hyperplastic enlargement and consistency. In the earlier stages they are small, isolated, and movable, while in advanced and well-developed cases of the disease they are larger, fused together into great bunches, and more or less fixed by fibrous investment. As a rule, the glands are soft and elastic, though sometimes they are hard and dense, and masses as large as an orange or pineapple may be seen. Single glands may be as large as a hen's egg, and the gland capsules may show connective-tissue proliferation and a thickening periadenitis. Extension of the lymphatic growth into the surrounding tissues by perforation of the capsule may occur. As a rule, the overlying skin is freely movable, though it may rarely be adherent. On section the tumors display a smooth white or reddish-gray surface in the case of the soft and almost fluctuating glands, and a grayish or a yellowish-white color if they are firm. The fusion of the swollen glands into nodular masses is also seen, and when ulceration through the skin has taken place suppuration of the glands may be revealed. In the harder tumors areas of necrosis have the appearance of caseation, and shining masses of fibroid tissue may be visible.

Microscopically, there is a typical hyperplasia of the lymph-cells often obscuring completely the reticulum of the gland except in the harder enlargements, where the fibrous proliferation shows a very distinct network. The change is a lymphadenoma of the lymphatic glands. Reed² states that the true form of the disease has a specific histology, showing large numbers of

¹ *Amer. Jour. Med. Sci.*, August 1916, p. 231.

² *Johns Hopkins Review*, vol. x, p. 133.

eosinophils and a peculiar variety of giant-cell, different from that of tuberculosis. Longcope, Ruffin, and others also believe that the disease shows histologic changes peculiar to itself. Gibbons, on the contrary, is strongly inclined to the malignant theory.

The cervical glands are most prominently involved. The superficial chains of glands—axillary, mediastinal, scapular, and pectoral—especially along the great vessels, are often found connected, and the inguinal, bronchial, and lumbar glands are also affected, though less frequently. The retroperitoneal glands are more frequently affected than the mesenteric; they have occasionally projected externally by perforation through the sternum.

The *spleen* is enlarged in about four-fifths of the cases, but only slightly. In the majority of cases there are disseminated throughout the organ whitish, lymphomatous growths or nodules from the size of a pea to that of a nut. Their histologic structure is like that of the lymph-glands (lymphadenoma). Occasionally the spleen alone is hyperplastic.

Fig. 42.—Temperature-chart of a case of pseudoleukemia.

Lymphomata may also develop in the tonsils, lingual follicles, intestinal lymphatics, liver, kidneys, lungs, brain, spinal cord, heart, testicles, retina, and skin. The bone-marrow often appears the same as in pernicious anemia.

Etiology.—There are no well-established *predisposing conditions* to which Hodgkin's disease is referable. In 75 per cent. of cases males are affected, and young and middle-aged persons—between the ages of ten and forty. In an analysis of 100 cases, 30 were under twenty years, 34 between twenty and forty, and 36 after forty (Gowers). The disease would seem to belong to the group of infectious granulomata, but the *exciting cause* is not known. In undoubted instances of Hodgkin's disease the lymphatic glands frequently harbor tubercle bacilli; hence it has been thought that the latter exercise a distinct causative influence. It must be remembered, however, that some of these may be examples of accidental secondary infection; others

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obstruction due to the pressure of very large axillary glands. The *heart's action* may be disturbed by pressure on the pneumogastric, and the heart itself may be dislocated by great gland-tumors within the chest. Under such circumstances the latter may be detected by dulness on percussion over the anterior mediastinal space.

Edema of the feet and legs may be an early indication of enlarged abdominal glands pressing upon the femoral veins. Albuminuria is not uncommon; ascites and hydrothorax are late conditions. *Jaundice* is sometimes attributed to pressure upon the bile-duct. *Gastro-intestinal disturbances* may be troublesome, and are usually symptomatic of lymphoid growths in the stomach and bowels. In thin individuals gland masses may be palpable over the abdomen. Deafness may be caused by growths in the pharynx.

Nervous Symptoms.—Inequality of the pupils and unilateral sweating of the face, owing to glandular pressure upon the cervical sympathetic, may be noticed in some cases. Sharp lancinating pains along the nerves may also be felt. *Pressure-paraplegia* and *neuralgic pains* variously distributed throughout the body should also be mentioned among the nervous manifestations.

Cutaneous Symptoms.—It has been suggested that the bronzing of the skin sometimes seen in Hodgkin's disease may be due to the pressure of enlarged glands upon the suprarenal capsules. An intense pruritus has been complained of, and the skin may be erythematous. Occasionally the thyroid and thymus glands are involved.

Spleen.—The slightly or moderately enlarged spleen can usually be felt just below the ribs, projecting toward the navel. Tenderness over the spleen and bones may be elicited. The characteristic feature in splenic pseudo-leukemia is the decided enlargement of the spleen without involvement of the lymphatics.

The *blood* shows a moderate diminution in the number of red corpuscles, and a corresponding diminution in the hemoglobin, the former in most instances numbering from 2,000,000 to 4,000,000 per cubic millimeter. In the early stages of the disease there is but little change in the leukocyte count, but in the later stages a high leukocytosis (20,000 to 60,000) of the polynuclear type with marked diminution of the lymphocytes is usually present. In the early stages there is usually a relative increase in the small mononuclears and a relative and absolute increase in the large mononuclear and transitional cells. An occasional normoblast may be seen. Blood-platelets are abundant (Bunting).

Diagnosis.—Pseudoleukemia is more readily confused with *tuberculous adenitis* than any other disease, particularly at the outset. Although an acute tuberculous adenitis may very closely simulate Hodgkin's disease and render a diagnosis almost impossible, more often the glands of tuberculous adenitis are slower in enlarging and extending than in this disease. In fact, extension of the lymphatic enlargements of tuberculosis is rarely seen as compared with pseudoleukemia. Again, tuberculous adenitis is most common in the young, is unilateral rather than circumferential in the neck, and attacks the submaxillary glands oftener than the cervical chains along the sternocleidomastoid. Again, periadenitis, adhesion, and suppuration of the glands occur in tuberculosis. Tuberculous foci in other organs may also be found. Intermittent attacks of pyrexia are an indication favoring Hodgkin's disease. In doubtful cases the glands (more than one) should be removed for microscopic examination. The tuberculin test will exclude glandular tuberculosis. Wessler and Greene state that in doubtful cases of Hodgkin's disease the demonstration of intrathoracic lymphomas by Roentgen ray examination may help to establish the diagnosis.

The blood should be examined in order to differentiate from *leukemia*.

Syphilis must be carefully excluded by the history, symptoms, and therapeutic test. *Neoplasms* of the lymph-glands may sometimes be difficult to distinguish from pseudoleukemia.

The diagnosis of *splenic pseudoleukemia* is to be made on the decided splenic enlargement without involvement of the lymphatics. The following conditions, however, must be distinguished: (a) Pernicious anemia with enlargement of the spleen: this is readily done by a blood examination; (b) cirrhosis of the liver, in which there is splenic enlargement; (c) the splenic tumor of chronic malarial poisoning. Here the blood should be repeatedly examined for the organism of Laveran if the patient resides in a malarial region; (d) idiopathic enlargement of the spleen without any anemia.

Prognosis.—This affection runs an almost invariably fatal course. The remissions and exacerbations of the disease are, however, notable. In some cases the termination may occur in a few months, but usually death ensues after the lapse of two or three years. It should be remembered that some instances of Hodgkin's disease seem to merge into a true lymphatic leukemia.

Grave indications are the rapid extension of the glandular enlargements, great debility, anemia, emaciation, steadily increasing and continuous pyrexia, thoracic pressure symptoms, hemorrhages, and marked anasarca. Sometimes the tumors diminish greatly before death. In certain cases general streptococcus infection, intercurrent diseases, or such complications as empyema or nephritis may be the immediate cause of death.

Treatment.—Surgical treatment is of no avail. It is claimed that exposure of the enlarged glands to the roentgen ray is followed by a decrease in glandular enlargements and an improvement in all symptoms. I have seen marked reduction in many cases of lymphatic enlargement of this nature, and in a smaller group, total disappearance. Simmons and Benet¹ state that radium and the Roentgen rays have a distinct beneficial effect, the former being of more value than the latter. The authors advise that treatment should not be limited to the palpable glands, but should be directed against the lymphatic areas of the body from the first. Hygienic measures and the use of all possible agencies to support the strength of the patient should be resorted to, and the administration of arsenic in gradually ascending doses, as for pernicious anemia and leukemia. The value of Fowler's solution is undoubted in many cases. Phosphorus has also been recommended, and the galvanic current may be applied topically. Tonics, nutrients, and such are of service. Vaccine therapy has been rather extensively advocated, but in view of the questionable etiology of the disease such a method of treatment seems irrational.

ANÆMIA INFANTUM PSEUDOLEUKÆMICA

The above title was given by von Jaksch to a form of anemia occurring in childhood that bears certain similarities to leukemia, but it is without the tendency to a fatal end. Giffin thinks it is quite probable that this condition is merely the infantile type of splenic anemia (*vide infra*), the increased leukocytes (30,000 or more) being merely a difference in the reaction of the blood due to infancy. W. J. Mayo corroborates this view and points out that a moderate leukocytosis (20,000 or more) may rarely be met in true splenic anemia. Krumbhaar² holds also that this condition is not an independent one, but is merely an atypical response of the infantile hemopoietic system, one of the primary blood diseases.

¹ *Boston Med. and Surg. Jour.*, December, 13, 1917, p. 819.

² *Amer. Jour. Med. Sci.*, 1915, cl, 227.

POLYCYTHEMIA WITH SPLENIC TUMOR

This is a special complaint of obscure pathogenesis. The spleen is quite hard and usually enlarged. A cheesy tuberculosis has been noted, but this is not constant.

Etiology.—Certain writers regard changes in the bone-marrow as primary, leading to increased erythroblastic activity. Defective venous tone may play a rôle in the pathogenesis. The Hebrew race is markedly predisposed. A majority of the cases occur during middle life, and “the cases are about equally divided between the sexes” (Engelbach and Brown). “I regard it as probable that there is a form of primary polycythemia of unknown etiology, characterized principally by marked polyglobulism and other hemic features, cyanosis, headache, vertigo, and splenic enlargement, but it must be of rare occurrence.” On the other hand, the majority of cases which have been reported have had a different etiologic pathology, circulatory stasis resulting from pressure of malignant tumors, valvular heart disease, gout, and the like.

Symptoms.—According to Reckzeh,¹ the first symptoms are vertigo, headache, mental apprehension, general weakness, and gastro-intestinal disturbance. In fully-developed cases marked cyanosis of the skin and mucous membranes, with dilatation of the veins and sometimes hemorrhages, are prominent features. The spleen may extend downward to the level of the umbilicus. The characteristic blood-findings are an enormous increase of the hemoglobin, rarely to 150 per cent., although the percentage is relatively low, and a high erythrocyte count, the estimation ranging from 7,000,000 to 12,000,000 in some cases. The leukocytes vary as to number, but often about normal figures are found. Hedenius² found the proportion of mononuclears abnormally high. The total volume of the blood is decidedly increased.

Geisböck describes a second form, or *polycythemia hypertonica* (erythrocytosis), in which the blood-pressure is, as a rule, quite high. The majority of cases are associated with arteriosclerosis and nephritis, but not all. Neither is viscosity of the blood responsible for the rise of arterial pressure. The changes in the bone-marrow, in one case at least, were identical with those of Vaquez's disease. In this variety the spleen is not enlarged, but otherwise the symptomatology and treatment are the same as in polycythemia with splenic enlargement. Mosse reports a case analogous to a few on record in which the polycythemia was accompanied by urobilin jaundice, the liver showing signs of cirrhosis at autopsy.

The *course* is exceedingly chronic, and the *prognosis* unfavorable.

The *treatment* is by arsenic, quinin, an iron-free vegetable diet, and a carefully regulated mode of life. The iodids have been advised in order to decrease the viscosity of the blood. The cerebral symptoms have been benefited by the nitrites. Venesection has proved of service in some cases. Splenectomy may be advocated. Hurwitz and Falconer³ report 1 case apparently cured after one year in which benzene and the Roentgen rays were employed in conjunction with each other.

¹ *Zeit. f. klin. Med.*, vol. lvii, Nos. 3, 4.

² *Svenska Läkaresällskapets Handlingar*, Stockholm, 1914, xl, No. 3.

³ *Jour. Amer. Med. Assoc.*, 1918, lxx, 1143.

DISEASES OF THE DUCTLESS GLANDS

DISEASE OF THE SUPRARENAL CAPSULES

ADDISON'S DISEASE

Definition.—A constitutional disease, characterized by a degeneration of the suprarenal capsules or semilunar ganglia, a bronzed or pigmented skin, great bodily and mental asthenia, feeble circulation, and gastro-intestinal irritability.

This affection is named in honor of its discoverer, Thomas Addison, of Guy's Hospital, London, who first described it in a monograph published in 1855, entitled "The Constitutional and Local Effects of Disease of the Suprarenal Capsules."

Pathology.—Addison emphasized the fact that while the suprarenal bodies were affected with a fibrocaseous alteration in many cases, the anatomic changes were by no means always the same. Both suprarenal capsules are usually diseased at the same time. Tuberculosis is the commonest condition, and is often associated with tuberculous lesions in other parts of the body, as in the lungs, bones, and other glands. Rarely, it seems to be primary, no other evidences of tuberculous infiltration being found. The capsules are enlarged, firm in places, and nodulated on the surface, owing to the caseous masses surrounded by fibrous tissue. Sometimes there is marked cicatricial contraction of the adrenals, and the adjacent structures may be found matted together with the capsules. *Microscopic examination* shows a reticulum of connective tissue surrounding a soft, cheesy, granular, and fatty detritus, lymphoid cells, and some giant-cells. Other morbid, non-tuberculous processes in the adrenals are atrophy of one or both glands from interstitial cirrhosis, carcinoma or sarcoma, and chronic inflammation.

Especial attention has recently been given to the condition of the *solar plexus* and *semilunar ganglia* of the abdominal sympathetic, and implication of these nervous structures by compression, cicatricial contraction, entangled in the cicatricial tissue surrounding the suprarenal bodies, or by chronic inflammation, is not infrequently discovered, together with a degeneration and deep pigmentation of the semilunar ganglion cells.

Enlargement of the solitary and agminated follicles of the intestine, and slight enlargement and some softening of the spleen are noted at times; parenchymatous or fatty degeneration of the heart, liver, and kidneys has also been noted in some instances. The thymus gland may be found to have remained normal, or even to have enlarged, perhaps. The deposition of pigment is in the same anatomic elements as in the negro—in the lower layers of the rete malpighii.

The pathologic connection between the symptomatic phenomena of Addison's disease and the anatomic lesions has not been made out. The experimental evidence regarding the functions of the adrenals may be briefly summed up: the medullary portion secretes adrenalin which acts upon the smooth muscle innervated by the sympathetic system; thus, when injected intravenously it causes a transitory violent heart action, rise in blood-pressure, dilatation of the pupil when the eye is cut off from its nervous supply, relaxation of the intestinal wall, uterine contractions, and so on; the secretion also exerts some considerable function in influencing other endocrin glands; thus injections produce a hyperglycemia. The cortical portion of the gland may play some part in the production of sexual characteristics; it is also concerned in cholesterin metabolism. It is presumed that in Addison's disease this internal secretory function is lost. Cases exhibiting the clinical phenomena of the disease without marked morbid change in the gland have been

attributed to destruction of the chromaffin system throughout the body, with inconspicuous changes in the gland (MacCallum). Again, marked changes have been observed in these glands, while during life no symptoms of the disease have been noted. In such cases it is presumed that the chromaffin system elsewhere has been able to carry on the function of the gland, bearing in mind that the chromaffin tissue is analogous to the medullary tissue of the suprarenal gland, that its function is the same, that the suprarenals are but the major part of a vast system, the chromaffin system, and that the chromaffin bodies are scattered extensively throughout the body along the course of the chains of the sympathetic ganglia. It is also maintained by some that the abdominal sympathetic nerves and ganglia are directly concerned in producing the clinical manifestations either by an independent morbid process or by extension from some adjacent organ. Others hold that both the adrenals and the sympathetic ganglia are the seat of pathologic changes. The data are not sufficient, however, to determine whether the principal involvement is nervous or secretory. Ramond and François hold that when the suprarenal glands are insufficient the thyroid may come to their aid, as shown by the marked improvement from thyroid feeding in the treatment of Addison's disease.

Etiology.—This is obscure. It has been held that some infection of the blood from without precedes the suprarenal and nervous lesions by Addison's disease. A *tuberculous* infection has also been emphasized by some investigators, and Fleming and Miller have reported a family with probable Addison's disease. A history of *injury* to the trunk has been noted in several cases. Addison's disease may be emotional in origin, cases having been reported to follow bombardments during the recent world conflict. The disease is more common in Europe than in America, though it is rare everywhere. Analysis of 183 cases showed 19 males and 64 females (Greenhow). While the disease may affect all ages (it may even be congenital), it is usually found in early or middle life—between fifteen and forty years of age. That Addison's disease is due either to a general neurosis or to disturbed hematopoiesis is merely hypothetical.

While it does happen frequently that tuberculosis or carcinoma affects the adrenals, the purest and most typical symptoms of Addison's disease are apparently primary in their development, and not those that usually attend the course of the former diseases.

Symptoms.—*Cutaneous Symptoms.*—The gradual pigmentation of the *skin* of various parts of the body may be one of the first evidences of the affection. This pigmentation may have either a dusky yellow, bronze or yellowish-brown, olive, deep or greenish-brown, or even black color. Although sometimes diffuse, the discoloration is not uniform over all parts of the body, but commences earlier, and becomes deeper especially on the exposed parts and where the normal pigmentation is marked, as the face, neck, backs of the hands, the axillæ, abdomen, groins, genital regions, and the areolæ of the nipples. Pigment-spots, often somewhat bluish in color, are also found on the *mucous membranes* of the mouth, lips, conjunctiva, and vagina. On the lips the discoloration takes the form of a dark streak, running lengthwise, near the junction of the skin and mucous membrane; or brownish patches or streaks corresponding to the points of pressure by the teeth may be noticed. Irregular stains with ill-defined borders may also be shown on the skin, corresponding to the lines of pressure exerted by garments, strings, suspenders, garters, etc. (Greenhow). Patches of *leukoderma* may be seen here and there, in marked contrast to the pigment deposits. The "white line," produced by drawing the finger lightly over the skin of the abdomen, is characteristic.

General Symptoms.—The constitutional symptoms may exist in a slight

degree before the pigmentation first attracts the patient's attention. There is gradual and progressive *asthenia* without apparent cause, great lassitude and loss of physical and mental energy, a low body temperature, breathlessness, headache, dizziness, tinnitus aurium, sighing, and fatigue. The *blood examination* shows a moderate reduction of the erythrocytes and hemoglobin, rarely becoming marked. There is no leukocytosis and often a leukopenia. The fat, particularly of the abdomen, may be well preserved.

Circulatory Symptoms.—The *heart's action* is weak and the pulse small and feeble; attacks of faintness and palpitation on exertion are common, as are functional murmurs and coldness and clamminess of the extremities. The blood-pressure is greatly reduced.

Gastro-intestinal symptoms are usually prominent. There is a loss of appetite, and nausea and vomiting may occur early and either be paroxysmal or persistent. The *tongue* may be clean, and the gastric disturbances do not seem to follow errors in diet. *Diarrhea* may be troublesome in the later stage, and is often associated with intractable vomiting. *Neuralgic attacks* of either sharp or dull, aching pain are referred to the epigastric, hypochondriac, and lumbar regions in about one-third of the cases. The *mind* is usually clear until near the last, but mental weariness is constant, and, as the later stages of the disease come on, the patient often lies in a somnolent, semicomatose state. The physiognomy expresses fatigue, dejection, and apathy; the speech becomes slow and incoherent, and in many cases the patient passes into delirium. *Prostration* is profound, the weakness being disproportionate to the general condition.

Renal Symptoms.—Polyuria is sometimes evident, but albumin is seldom present. The amount of indican is increased, as it is in the urine of all of the cachectic diseases associated with destruction of albuminoids. There is usually a diminished excretion of urea, but urobilin and uromelanin may be present in abnormal quantity. Tubercle bacilli may be found in the sputum.

Diagnosis.—The principal error in diagnosis is in the assumption that the case is one of Addison's disease, simply from the presence of patches of pigmented skin. Other conditions in which the discoloration may simulate that of Addison's disease are the following: (1) Carcinomatous and tuberculous disease, particularly when seated in the abdomen and when involving the peritoneum. (2) Hepatic disease, such as the cirrhosis of diabetes, protracted jaundice, and chronic congestion ("liver spots"). (3) Pregnancy, and uterine disease, in which the patchy discolorations (chloasmata) appear principally upon the face. (4) Irritation of lice and dirt and exposure, as in the case of tramps and vagrants ("vagabond's disease"). (5) Tinea versicolor. (6) Melanotic sarcoma. (7) Exophthalmic goiter. (8) Post eruptive staining of syphilitic eruptions. (9) The administration of silver nitrate for a long time (argyria). (10) Marked brunette complexions and racial admixture.

When the pigmentation is scanty, of course the diagnosis is more difficult; but in all cases of pigmentation in which other causes may be excluded the progressive asthenia, unaccountable vomiting and diarrhea, easily compressible pulse, great bodily weakness, mental hebetude, and lumbar and epigastric pain render the diagnosis of morbus addisonii, or *malasma suprarenale*, justifiable. The bronzing of the skin may precede as well as follow the constitutional symptoms.

Boyd reports a case of *acute suprarenal insufficiency*. In the negro the diagnosis of this affection is extremely difficult, both on account of the naturally dark skin and because of the dark discolorations of the oral mucous membrane, found even in health.

Prognosis.—The course of Addison's disease is almost always chronic,

DISEASES OF THE THYMUS GLAND

Physiologic Pathology.—Nothing is known definitely concerning the functions of the thymus gland. It is not a gland of internal secretion, and probably exerts whatever effect it has on the body economy by means of small round cells which resemble closely lymphocytes, and which are thought by many to be genetically and biologically lymphocytes; by others, epithelial cells. Insufficiency of the thymus may cause changes in the bony system somewhat analogous to those found in rickets or osteomalacia, or it may be responsible for certain grades of idiocy, notably Mongolian idiocy, according to Sajous. While there is no evidence that the thymus produces an internal secretion, a certain imperfectly understood "relationship exists between the thymus and organs that do produce an internal secretion, such as the thyroid (in Graves' disease), parathyroids, pituitary body (in acromegaly), the ovaries, testicles (atrophying as the sexual organs develop), etc.; and extracts of the thymus are said to cause a fall in blood-pressure and rapid action of the heart" (A. O. J. Kelly). The thymus attains its greatest relative size as compared with the body weight about the second year of life, but continues to grow until adolescence, when its greatest weight is attained, about 37 gm. (Hammar). From this time on it gradually atrophies, although functioning thymic cells apparently persist throughout life.

ENLARGEMENT OF THE THYMUS

The thymus may become enlarged from various causes (tumor formations, cyst formations, Graves' disease, acromegaly, Addison's disease, Hodgkin's disease, leukemia), and is secondarily affected in tuberculosis, syphilis, and pyogenic infections. On the other hand, atrophy of the thymus has been observed (*e. g.*, infantile marasmus).

STATUS THYMICOLYMPHATICUS

(*Status Lymphaticus; Thymic Asthma; Hyperplasia*)

Definition.—Hyperplasia of the thymus and lymphatic tissues, associated with corpulency and hypoplasia of the heart and blood-vessels, and characterized clinically by stridor and sudden death.

Etiology.—The condition is met with in young children with persistent thymus, although in most cases reported hyperplasia of the entire lymphatic system has been noted—the *lymphatic constitution* of Paltauf. The cause of the *constitutio lymphatica*, however, is unknown. Says Warthin, "Status lymphaticus may be the consequence of a number of primary morbid processes, such as syphilis, rachitis, some latent infection, auto-intoxication, etc., that are characterized by excessive demands upon the lymphoid and myeloid tissues." Olmacher noted in 18 cases of epilepsy a large thymus gland with hyperplasia of the lymphatic glands throughout the body, and of the lymph-follicles of the mucous surfaces.

Symptoms.—In early life the symptoms are those of stenosis of the air tract. There is inspiratory and expiratory stridor, as a more or less audible whistling respiration (Schwinn). There are cases in which death occurs without previous stridorous dyspnea, while in others the stridor is congenital or develops soon after birth, and is subject to exacerbations on slight provocation, as screaming or crying or as a result of an acute infection (Kopp's asthma, Millar's asthma). In other instances the symptoms of suffocation precede the fatal

termination. Potts reports 4 cases where children died in this manner after the insertion of a tongue depressor. In later life the symptoms are still those of pressure when the thymus is considerably enlarged, but the pressure may be on the blood-vessels as well as the trachea, causing cyanosis of the face and edema of the upper portion of the body. Enlargement of the thymus has been found frequently in adults who died suddenly without apparent cause.

In cases of this disorder the syndrome has been subdivided into three types: (1) *Status thymicus*, in which there is marked enlargement of the thymus without marked change in the lymphatic system; (2) *status thymicolymphaticus*, slight enlargement of the thymus, but general hyperplasia of the lymphoid tissue throughout the body; and (3) *status lymphaticus*, in which the thymus is apparently unenlarged (Newton¹).

Physical Signs.—Among *physical signs* are: inspiratory dilatation of the nostrils, cyanosis, and marked retraction of the supraclavicular, infraclavicular, and intercostal spaces. The fontanelles are sometimes taut—this in the absence of meningeal retraction is a sign of some value. D'Oelsnitz² emphasizes the unusual extent and intensity of the dullness over the manubrium and toward the left. Schridde³ observed enlargement of the lingual follicles. For diagnostic purposes a roentgenographic examination gives trustworthy results.

The **prognosis** is highly unfavorable. The sudden death is due to thymic enlargement with secondary laryngeal spasm.

Treatment.—Any recognizable causative factors, *e. g.*, rachitis, anemia, etc., should be treated on accepted therapeutic principles. The roentgen rays have given splendid results. Operation with a view of removing the offending organ should be undertaken, although there are cases in which the child expires before medical aid can be procured. Siegel in one case, a boy of two and a half years, elevated and stitched the thymus to the fascia over the sternum, with the result that the threatening dyspnea disappeared and the child eventually made a good recovery.

DISEASES OF THE THYROID GLAND

THYROIDITIS

Definition.—Acute inflammation of the thyroid gland. The gland may either have been previously healthy or the seat of a goitrous enlargement; when inflammation attacks previously diseased or enlarged thyroid tissue the term *strumitis* is often used.

Pathology.—The gland is swollen, boggy, and generally the seat of abscesses; the numerous blood-vessels are engorged; and hemorrhages, thrombi, and areas of tissue-necrosis are found.

Etiology.—Thyroiditis is seldom primary in origin. It may be caused by traumatism, but usually it is secondary to one of the infectious diseases, especially typhoid fever, Groedel⁴ finding that in 73 cases of thyroiditis, 40 were consecutive to the former disease. Less frequently it follows small-pox, typhus, malaria, and rheumatism. Hemorrhages into the substance of a goiter, whether apoplectic or traumatic, may predispose to a strumitis that may be excited by the introduction of streptococci by an unclean needle, etc. Repeated congestions of the thyroid or a simple acute congestion may dispose to thyroiditis.

¹ *Amer. Jour. Med. Sci.*, 1919, clviii, 534.

² *Bull. de la soc. de Pédiat.*, Paris, December, 1911.

³ *Münch. med. Woch.*, November 26, 1912.

⁴ *Deutsch. med. Wchnschr.*, December 9, 1915.

Symptoms.—There are *fever, pain, swelling, and suppuration* in one or the other lobe of the gland. *Venous obstruction* may be serious and give rise to vertigo, headache, cyanosis, and epistaxis; and compression of the windpipe by the great swelling may cause death before the abscess bursts. Resolution occurs infrequently, especially in the “strumous” cases. Indeed, the symptoms of a strumitis are usually more severe, owing to the greater size of the thyroid, a tendency to metastasis, and to the burrowing of pus into adjacent tissues leading to perforation and rupture of the abscess into the trachea or esophagus. Lahey¹ calls attention to two consistent signs of thyroid abscess—limitation of chin elevation and depression of the chin on the sternum when swallowing.

Diagnosis.—Thyroiditis must be differentiated from the *laryngeal perichondritis* that is also seen in the course of infectious diseases, as typhoid fever and small-pox. *Simple congestion*, especially in women from emotional or menstrual disturbances and interference with the circulation from tight collars and the like, must be excluded.

Sclerotic Thyroiditis.—Riedel has described a form of thyroiditis of rapid development involving the entire gland, with fibrous connective-tissue formation and adhesions to surrounding structures. Serious symptoms may result from compression of the trachea and recurrent laryngeal nerves.

Prognosis.—The outcome is usually favorable in all cases in which spontaneous rupture occurs externally or when evacuation of the pus is effected. Myxedema may result from destruction of the gland.

Treatment.—The pus must be evacuated, and tracheotomy or thyroidectomy may become necessary.

GOITER

(*Simple Goiter; Non-hyperplastic Goiter; Struma; Bronchocele*)

Definition.—A chronic hypertrophy and hyperplasia of a portion or the whole of the thyroid gland. It is of obscure origin, and is subject to various degenerative changes. Congenital goiter occurs and is not infrequent.

Pathology.—Several different varieties are described. In the *simple hypertrophic* or *parenchymatous* form there is a hyperplasia of all the original tissue elements. The majority of the cases belong to the hypothyroid type, in which a debilitated gland becomes hyperemic but reacts imperfectly to different kinds of intoxication. The *follicular* form shows an increase of the true glandular elements alone.

Fibrous goiter is that variety in which the interstitial tissue or stroma is increased out of all proportion to the hyperplasia of the follicles. This variety of goiter may have an inflammatory origin (thyroiditis). In old cases marked sclerosis may be assumed. There is a *vascular* variety, in which the blood-vessels are enormously dilated. More commonly the veins are affected, but in the aneurysmal variety the arteries are chiefly involved. The intense venous variety of vascular goiter has been denominated “cancerous tumor of the thyroid,” and the whole gland may in such cases be quite elastic and like spongy erectile tissue. Follicular hyperplasia is often associated with vascular enlargement.

The special varieties of goiter due to degenerative changes are the *cystic, myxoid, colloid*, and *calcareous*, and of these the first named is the most common. It consists in the development in a large goiter of one or more large or all cysts filled with different kinds of fluid of varying consistency. Sometimes the liquid is colloid or mucinous in nature, and contains the residue of

¹ *Boston Med. and Surg. Jour.*, January 18, 1917, p. 94.

Dettrich and Osler have each reported an instance of a goitrous growth affecting aberrant portions of thyroid found in the upper region of the pleural cavity, one on the right and one on the left side.

Sudden death may ensue in a few cases, either from pressure on the vagi or from a severe hemorrhage.

Auscultation often reveals a loud blowing murmur, especially marked in the vascular bronchoceles. *Palpation* over the tumor often shows the bosselated surface present in cystic goiter; fluctuation may also be detected in such cases, as well as over the abscess of a strumitis.

Diagnosis.—Goiter is easily differentiated from other enlargements. The constant location and the character and course of growth of the bronchocele are distinctive. If both lobes of the thyroid are affected, making a symmetric swelling, the diagnosis is almost assured. Bronchocele is not easily confounded with other cervical tumors, such as *lymphadenoma*, *glandular tuberculosis*, *carcinoma* or *abscess* of the *thyroid*, or sebaceous cysts. A characteristic feature of tumors of the thyroid is their vertical movement during the act of deglutition.

Prognosis.—This is guardedly favorable as to life, but unfavorable as to cure. The course is chronic.

Treatment.—Prophylaxis should be practised in goitrous districts by the drinking of boiled water only, and removal to a non-goitrous region is advisable. In addition to water purification, other hygienic reforms have been responsible for reputed improvement in certain localities. Kimball, Rogoff, and Marine¹ in their studies at Akron, Ohio, have shown that simple goiter may be prevented by the administration of 0.2 gm. of sodium iodid for a period of ten days twice a year. Ergot or belladonna in progressively increasing doses may do good in vascular goiters. The younger and softer goiters may also be benefited by electrolysis, needles attached to the negative pole being inserted into the substance of the tumor, while a large sponge or clay positive electrode is placed in the vicinity.

In the older, fibrous, and degenerated goiters surgical treatment alone may be of service. Injections of iodine, tapping of cysts, incisions of the isthmus, and ligature of the thyroid arteries have been practised among the lesser operations. Thyroidectomy, or a partial extirpation of the thyroid, is the radical and final operation. Recently the fresh, chopped thyroid gland of the sheep, spread on bread, was given in 20 cases of follicular and parenchymatous goiter with gratifying results. Complete recovery, in an anatomic sense, however, was realized in 2 cases only. The administration of thyroid has transformed several cases of simple goiter into those of the exophthalmic type. McCarrison² has treated 33 cases by means of a composite vaccine, with marked success.

EXOPHTHALMIC GOITER

(*Hyperthyroidism; Hyperplastic Goiter; Graves' Disease; Basedow's Disease*)

Definition and Nature.—Although the view cannot be unreservedly accepted, exophthalmic goiter is probably of thyroid origin and is dependent upon an abnormal action (or overaction) of the thyroid gland; it is characterized clinically by tachycardia, tremors, enlarged thyroid, and exophthalmos. Among other leading theories the following may be briefly stated: (1) that endogenous or exogenous poisons, or shock, either physical or emotional, of the centers which govern the thyroid and adrenal glands cause overactivity of these organs (Sajous); (2) that the presence in the blood of abnormal amounts

¹ *Jour. Amer. Med. Assoc.*, 1919, lxxiii, 1873.

² *The Lancet*, London, February 10, 1912.

of amino-acids, resulting from an increased rate of metabolism, is a stimulus to the activity of the thyroid; (3) that the greater thyroid secretion is dependent upon an excess of iodized protein circulating in the blood, and (4) that it is a disease of the central nervous system associated with a chronic intoxication.

The theory held by Möbius, that exophthalmic goiter is attributable primarily to a disturbance of the function of the thyroid ("hyperthyroidation"), a condition directly opposed to the lack of thyroid function, as in myxedema, is amply supported by clinical evidence, the complex symptom-group of the former being directly antagonistic to that of the latter disease. Thyroid feeding, moreover, while it sometimes causes parenchymatous goiters to disappear rapidly, usually aggravates the symptoms of Basedow's disease. Marion¹ claims that myxedema and Graves' disease are two different syndromes, but the same pathologic process, the former being due to a lack of sufficient metabolized iodine, whereas the latter is the result of the action of excessive unmetabolized iodine. The iodine relation to the disease is being slowly elucidated. Thyroid tissue has an extraordinary affinity for iodine. In exophthalmic goiter there is an oversecretion and a decreased retention of iodine. Kendall² has been able to produce from an acid-insoluble compound of the thyroid protein a crystalline substance containing 60 per cent. of iodine, which, injected into animals or man, reproduces the symptoms of hyperthyroidism. Two years later Kendall was able to determine the structural formula of this substance, thyroxine. The following year thyroxine was prepared synthetically. Kendall³ has shown that thyroxine has very definite physiologic functions and that this physiologic activity of the substance is produced by the CO—NH group in the formula, rather than the contained iodine. Regarding the *pathologic changes* in the thyroid little is known. Brissaud found in 25 cases changes in the thyroid and, although the glands showed no changes peculiar to this disease, yet quantitatively the lesions were always such as to make "hyperthyroidation" possible. Plummer⁴ states that whatever the primary cause, the symptom-complex of the disease is directly attributable to hyperplasia of the thyroid. In nearly 50 per cent. of all cases of Basedow's disease a tendency to tardy hyperplasia or tardy involution of the thymus is evident (Kocher). Hector MacKenzie believes that atrophy of the parathyroids may be the cause of some of the more serious symptoms. Muscular changes, probably resulting from toxemia, explain the profound muscular weakness (Askanazy). Jaunin and Gautier contend that chronic iodism and exophthalmic goiter are practically the same condition. DuBois has shown that in exophthalmic goiter there is increased basal metabolism, which also stands out as the chief symptom of hyperthyroidism. Stimulation of the cervical sympathetic causes secretory activity in the thyroid (Cannon). Likewise, injections of adrenin have the same effect.

Etiology.—It is more common in women than in men. A table of 200 cases showed 161 females and 39 males (Eshner); and, although it has been met with at both extremes of life, it is seen usually in adults. The influence of heredity is undoubted, and several members of a family may suffer, persons that possess a sensitive nervous organization being especially prone to the disease. Exophthalmic goiter may develop after a trauma. The adrenals often are insufficient in this disease (Matti).

Among direct causes are emotional disturbances, worry, severe acute disease (noted in two of my cases), and prolonged mental or physical strain. Among belligerent soldiers in the European War an incomplete form of the

¹ *Berl. klin. Woch.*, 1913, 1, 1296.

² *Jour. Exper. Med.*, December, 1915.

³ *Jour. Amer. Med. Assoc.*, 1918, lxxi, 871.

⁴ *Amer. Jour. Med. Sci.*, December, 1913.

disease due to the emotions of the campaign, and the overuse of tea, coffee, and tobacco has been observed.

The disease may also occur as a secondary complication in the course of simple goiter, affections of the nose, and pregnancy; this variety, however, is to be distinguished from the primary or essential form. Evans, Middleton, and Smith found an exciting focus of toxin formation in the tonsillar crypts in 22.8 per cent., and nasal together with tonsillar lesions in 90 per cent., of 362 goitrous individuals. Again, in 23 individuals to whom emetin was administered, a reduction of the bulk of the goiter was appreciable in 18, though *endamebæ* could not be demonstrated in the thyroid gland.

Symptoms.—The development of the characteristic symptoms is generally *gradual*, though it may rarely be *rapid*. In the so-called abortive form the symptoms arise somewhat rapidly, but early subside.

In *acute* Basedow's disease the symptoms consist of an excessively rapid action of the heart, incessant vomiting, purging, and marked exophthalmos, with or without pronounced cerebral symptoms. J. H. Lloyd's case proved fatal after an illness of three days. Schlesinger insists that acute exophthalmic goiter should be suspected in every case of rapid loss of weight.

In the *chronic* form heart-hurry is almost constantly a conspicuous early symptom, and not seldom have I found that it precedes for a long period of time the appearance of the remaining characteristic features (enlargement of the thyroid, exophthalmos, and tremor). The pulse remains at or over 100 beats per minute, and upon unusual exertion or excitement the heart's action becomes violent and irregular, the pulse even reaching 160 or over. Palpitation, often with breathlessness, is a distressing symptom.

Cardiac Physical Signs.—*Inspection* reveals a forcible impulse that is not displaced, though late in the affection it may be much extended in superficial area. The carotids and the abdominal aorta beat violently, and the capillaries and veins of the hands may also pulsate visibly. *Palpation* detects an increased force of the cardiac impulse. The area of *percussion-dulness* may be somewhat increased, as hypertrophy and secondary dilatation supervene. On *auscultation*, blowing murmurs over the heart and great vessels, as well as an increased accentuation of the valvular sounds, may be audible for some distance from the patient. Distinct *bruits* may be heard over the base and manubrium. A bruit, synchronous with the pulse, has been heard over the eyeball in this disease by Snellen, Riesman,¹ and others. Krumbhaar² has shown that progressive hypertrophy and overaction of the heart results in myocardial degeneration that may be manifested by any of the types of cardiac irregularity.

Exophthalmos.—Protrusion of the eyeballs is usually present. The degree of exophthalmos varies greatly from time to time in the same case—a fact that points to an increased amount of blood or lymph in the orbit as its cause. In advanced cases permanent prominence of the balls may be attributable to augmentation of the orbital adipose tissue. On closing the eyes a rim of white is visible above and below the cornea; this and von Graefe's sign, immobility of the upper lid when the eye is turned downward, are two symptoms of great diagnostic importance. Möbius has called attention to the inability to converge the eyes upon near objects; and Stellwag, to an apparent separation of the eyelids, due to spasm or retraction of the upper lid. The pupils and the vision are unaffected, while the patient winks less often than in health. Curschmann holds that instillation of epinephrin causes mydriasis that is prompt, marked, and lasting for several hours in hyperthyroidism. Slight

¹ *Jour. Amer. Med. Assoc.*, April 29, 1916, p. 1381.

² *Amer. Jour. Med. Sci.*, 1918, clv, 175.

signs of exophthalmic goiter may be found. Degrees of the thyrotoxicosis exist which may vary from mild evidences of overfunctioning of the gland to extreme signs of Basedow's disease; the disease may run a chronic, mild, prolonged course, or may be acute and extremely rapid, with the appearance of symptoms of grave import. Holmgren has called attention to the unusual growth in height in children with exophthalmic goiter.

Diagnosis.—The diagnosis of Graves' disease may be made when tachycardia and fine, general muscular tremors are present. Exophthalmos and enlargement of the thyroid are often late-appearing symptoms, and are as often temporarily lacking even in fully developed cases. Rarely either or both of these signs may be permanently absent. On the other hand, in a few cases exophthalmos is the sole characteristic feature for a long time, though it is eventually followed by an unmistakable symptom-group. Two diagnostic findings of great value are: (1) hyperglycemia and (2) increase in the basal metabolism. The first test depends upon the well-marked rise in blood-sugar persisting for longer than two hours that follows the injection of 100 gm. of glucose in the presence of thyrotoxicosis. The second test is the marked increase of basal metabolism that occurs in such cases, and by basal metabolism we mean the heat production of an individual when food metabolism is eliminated by twelve or more hours' starvation, and voluntary muscle metabolism is done away with by complete rest in the prone position, leaving only the absolutely necessary for life metabolism of the cardiovascular and respiratory systems, with the addition of the minute amount of heat produced by the secretory systems and by chemical changes between the body cells. The basal metabolism is studied by various methods, of which the Benedict respiration apparatus is the most practical. The heat production is calculated by determining the gas exchange in relation to the height, weight, age, and sex of the individual. Normally the calories per square meter per hour may vary about 10 per cent. for the standard approximately 40 calories. In cases of exophthalmic goiter Means and Aub¹ found increase of 50, 60, 70, and even 80 per cent. above the standard. McCaskey,² in his paper on these two diagnostic aids, states that blood-sugar increase is a negative sign of particular value, while Leuders³ also believes this is a most valuable test for determining disturbances of the thyroid. The absence of alimentary hyperglycemia rules out most definitely non-thyroid cases. The administration of thyroid substance or thyrotoxin will aggravate the symptoms in true cases of hyperthyroidism. As pointed out by Smith⁴ this test gives very convincing evidence in favor of the diagnosis of hyperthyroidism. The Goetsch test is usually positive in cases of hyperthyroidism, though it is more truly a test for the determination of sympathetic overstimulation. It is performed as follows: 5 c.c. of a 1 : 1000 solution of adrenalin chlorid injected subcutaneously. A positive reaction is manifested by an increase of pulse-rate and rise of blood-pressure of from 10 to 20 points, exaggeration of tremor, palpitation and nervousness, appearing within twenty minutes of the injection.

In differentiating the condition it must not be forgotten that many of the symptoms are present in other diseases. For example, exophthalmos, which is certainly a most striking symptom, is frequently present in chronic nephritis as pointed out by Barker. Exophthalmos is also found in that rather rare condition, *oxycephaly*, "a cranial deformity associated with exophthalmos and impairment of vision" (Osler). Tachycardia, tremor, thyroid enlargement are all

¹ *Arch. Int. Med.*, 1919, xxiv, 645.

² *New York Med. Jour.*, 1919, cx, 607.

³ *Arch. Int. Med.*, 1919, xxiv, 432.

⁴ *Jour. Amer. Med. Assoc.*, 1919, lxxiii, 1828.

Krumholz holds that serum of thyroidectomized animals is the most valuable drug yet offered. Antithyroid preparations, such as thyroidotoxin, give promise of good results. Mobius' antithyroidin (a preparation of the blood of sheep in which the thyroid gland has been removed some time previously) has given good results. The dose is from 10 to 30 minims (0.65–2.0) twice daily, given for a period of twenty days. None of these preparations have, however, fully stood the test of time. Pal states that pituitary extract displays a pronounced antagonistic action on the thyroid when functioning to excess. Hoppe has found corpus luteum to be an active beneficial therapeutic agent.

(c) **Operative Treatment.**—Starr has collected 190 cases in which some form of operation was performed. Of these, 74 are reported as completely cured, many of them having been watched two to four years before the result was published; 45 of the cases were improved, and 23 died immediately after operation. The symptoms preceding the fatal result are sudden hyperpyrexia, with rapid pulse, nervous distress, sweating, cardiac failure, and collapse. The statistics of Kinnicutt and of Abram (particularly the latter) show less encouraging results from operation. It is to be remembered that under the most favorable circumstances a complete cure will not be attained immediately. In cases unimproved by non-operative treatment in a reasonable time partial thyroidectomy may also be advised. Bilateral resection of the sympathetic nerve has been done by Schwartz and others, with marked benefit, thus confirming Cannon's work. Rehu presents a statistical report of 32 resections of the sympathetic: 31.1 per cent. were cured; 50 per cent. improved, 12.5 per cent. were unimproved, and 9.5 per cent. proved fatal. F. Hartley states that, compared with sympathectomy, partial thyroidectomy yields better results, both as regards mortality and cures. Crile claims benefits from ligation of the thyroid artery, which breaks the nerve supply between the brain and the thyroid gland. Both in acute exophthalmic goiter and during an acute exacerbation of the chronic form operative intervention is contraindicated. Klose recommends that in all severe cases of Basedow's disease the thymus be removed. Kocher states that when there is hyperplasia of the thymus the patient might be prepared for an operation on the thyroid by a course of thymus extract and Roentgen exposures of the thymus just before the thyroidectomy. Porter¹ recommends the injection of boiling water in the gland in cases of circumscribed hyperplasia and those with moderate or severe symptoms and relatively small glands.

Pfähler noted decided improvement from the *Roentgen-ray* treatment in about 75 per cent. of 51 cases. Berger and Schwab also contend that this agent is fully equal to any therapeutic measure. Holmes and Merrill² believe that the Roentgen ray should be employed in all cases before resorting to surgery, certainly long enough at least to destroy the thymus. In regard to this treatment medical men are more or less at odds. The surgeon holds that as a curative measure it is inferior to surgery; the roentgenologist, that it is superior to surgery; while the internist believes that it has a certain value in some cases, that it should be tried in cases of thyrotoxicosis that are not acute, and that it should be very definitely used in cases that have been operated upon and show a return of their symptoms.

Bloodgood insists upon two procedures preliminary to operation: (1) The removal of all possible foci of infection; (2) rest in bed for from six to twelve weeks. Crile's method of performing thyroidectomy is first to accustom the patient to the usual preoperative procedures and then to do the operation when the patient does not anticipate or expect it—"steal the gland away."

¹ *Surg., Gyn., and Obst.*, January, 1915.

² *Jour. Amer. Med. Assoc.*, 1919, lxxiii, 1693.

marked alterations of temper; and a curious persistence of thought and action, overriding all attempts at interruption by friends or observers."

The *temperature* in myxedema is usually more or less subnormal. The basal metabolism, according to Means and Aub,¹ is materially lowered. Albumin is occasionally found in the urine, but the quantity of nitrogen excreted is small owing to the diminished metabolism of proteins. *Hemorrhages* from the nose, gums, and bowels may occur. *Ascites* may be present in some cases, and may simulate ovarian tumor. The thyroid is not palpable, partly because of its atrophy, and partly because of the thickened myxedematous tissues of the neck.

The **diagnosis** is not difficult if one bears in mind the characteristic manifestations described above. Myxedema could hardly be mistaken for acute or chronic nephritis in the absence of pitting, etc., as some have supposed. Chapman mentions a solid appearance of the conjunctiva as an early sign of diagnostic value.

As in overfunctioning of the thyroid so in deficiency, degrees and grades of the disfunction appear. The severe type of hyposecretion, as represented by the above description of myxedema, is rare; but milder, less pronounced cases are frequently seen which may present only a few of the characteristic findings. For example, Gracobini² presents evidence that thyroid insufficiency may be responsible for sterility. It is such cases that present difficulty in diagnosis, not the typical case of advanced myxedema.

The **prognosis** is guardedly favorable in a majority of the cases since the introduction in the treatment of thyroid feeding. The course of the disease is slow, however, often lasting from five to fifteen years, and death from intercurrent disease is not uncommon.

Treatment.—Until the advent of thyroid feeding the treatment of myxedema was palliative, and usually unsuccessful.

A warm and equable climate is very desirable owing to the subnormal temperature from which the patients frequently suffer. The various warm baths—as the Turkish, Russian, and electric—should be employed for the same reason. Pilocarpin has been recommended, and strychnin and arsenic have been administered for their tonic effect.

Since the brilliant results obtained by Murray, however, the internal use of the thyroid gland of sheep or calves has come into a well-deserved favor in the treatment of all cases of myxedema, whether of the so-called true form, of sporadic cretinism, or of the cachexia strumipriva.

From 3 to 5 grains (0.2–0.3) of the powdered gland will be a safe commencing dose in adult myxedema: a caution, however, is necessary regarding the various manufactured preparations of the thyroid gland, some of which are impure and even dangerous.

The toleration of thyroid feeding does not depend upon the volume, but upon the functional activity of the gland, and this fact, together with the evidences of toxic action reported in some instances of the administration of thyroids to a maximum degree, make it important to urge again—as intimated above—the necessity of small dosage at the beginning of treatment, and the most careful and judicious increase in the quantity given. The additional fact of an occasional cumulative action should also be emphasized. Should vomiting, renal pain, tachycardia, suffusion of the face, syncope, vertigo, or marked headache supervene, the remedy should be stopped at once. The treatment may be resumed again cautiously, alternating with intervals of

¹ *Arch. Int. Med.*, 1919, xxiv, 404.

² *Semana Medica*, 1919, xxvi, 272.

cessation. I have observed that by combining arsenic with any of the preparations of thyroid the toxic effects of the latter can be largely obviated. Good results are obtained usually within a month, though it is probable that even after all the symptoms have subsided the treatment may have to be continued at intervals. The activity of the thyroid is enhanced by the presence of iodine (Hunt and Seidell). If a thorough trial of thyroid treatment fails, then thyroid grafts should be resorted to (Payr).

Cretinism, Sporadic and Endemic.—Here there is a congenital atrophy or absence of the thyroid gland, or an enlargement by the growth of fibrous tissue at the expense of the glandular elements. Cretinism may also develop in early infancy. The patients are often the children of parents having various neuroses and goiter. This fact I have confirmed in a statistical study of 73 cases. Syphilis has also been supposed to have a causative influence, though of the cases collected by me since 1905 in none was there a definite evidence of previous syphilis in the parent. Congenital myxedema is quite common only in regions where goiter is endemic. A marked sporadic case has been in the Philadelphia Hospital for many years.

Symptoms.—Cretins are dwarfs with large heads and faces, thick lips, thick protruding tongues, broad bodies and members, and prominent abdomens. The subcutaneous tissues are myxedematous. In 4 of 36 cases the thyroid was enlarged (Anders). Umbilical hernia is often present. The mental condition is that of idiocy, and physical growth is retarded and slow. Speech is unintelligible or nearly so, and the voice harsh. Walking may never be accomplished, and is always slowly developed. There is anemia. Rheumatic symptoms sometimes occur.

Prognosis.—The disease is progressive until about the fifteenth year in those cases developing during early childhood. Congenital cases usually die shortly after birth. At the twentieth or thirtieth year "the mental and physical characters are those of childhood."

Treatment.—Thyroid feeding has been followed by beneficial results, the checked growth having recommenced and the cretinic aspect having been largely lost. S. Küh has employed iodothyron in one case with quite as satisfactory results as those from the dried thyroid. Pahr has implanted a portion of the thyroid gland of the mother into the spleen with manifest amelioration of the mental state of the child. Paschoud, however, claims that no benefit is derived from thyroid grafts in cretinism.

Operative Myxedema, or Cachexia Strumipriva.—Extirpation of the thyroid for surgical reasons has given rise to the gradual production of symptoms and conditions identical either with true myxedema or with the cretinoid state. Partial removal of the gland is not followed by cachexia strumipriva, nor is complete thyroidectomy when accessory glands are present elsewhere.

The administration of raw or broiled thyroids, or of their various extracts or preparations, must also be employed in this form of myxedema, and should be continued throughout the rest of the patient's life, perhaps with intervals of withdrawal of the feeding until the improvement gained begins to lapse.

TUBERCULOSIS OF THE THYROID GLAND

The thyroid gland is only rarely invaded by tubercle bacilli, for the reason that it has greater power to resist them than other organs. Pollag,¹ who has summarized the literature on the subject, states that it is possible that its iodine content may be responsible for this. When the thyroid is attacked, it indicates that the resisting powers of the organism are at a very low ebb.

¹ *Beiträge zur Klinik der Tuberkulose*, Würzburg, 1913, xxvii, No. 2.

The *symptoms* are similar to and the *diagnosis* is reached as in tuberculosis of the lymph-glands. The *treatment* of thyroid tuberculosis should be on the principle of the removal of the focus, while sparing the sound tissue as much as possible. If symptoms follow from loss of thyroid functioning, thyroid feeding or transplantation should be instituted.

DISEASES OF THE PARATHYROID GLANDS

The parathyroid bodies consist, as a rule, of two pairs, upper and lower, on either side of the lateral lobes (posterior inner edge) of the thyroid gland. These are small ovoid structures from 1 to 3 mm. in diameter and 6 to 8 mm. in length. Recent studies by Halsted and others show that their removal in animals gives rise to symptoms simulating tetany (*vide* p. 1172), which disappear as a result of parathyroid feeding or transplantation. MacCallum has shown that the parathyroid bodies control calcium metabolism; they also, to some extent, influence carbohydrate metabolism. While parathyroid preparations have been used with success in tetany, they have no therapeutic effect in diseases of the thyroid gland, convulsive disorders, and the like.

PART VI

DISEASES OF THE RESPIRATORY SYSTEM

I. DISEASES OF THE NOSE

ACUTE RHINITIS

(*Acute Nasal Catarrh; Acute Coryza*)

Definition.—An acute catarrh of the schneiderian membrane, sometimes tending to involve the adjacent sinuses and passages. It is known to the laity as “cold in the head.”

Etiology.—Its most conspicuous cause is exposure to drafts of air and to the influence of the atmospheric vicissitudes that are especially prevalent during the winter and spring seasons. It often results from the inhalation of irritants (physical, chemical, or biologic). It may also display epidemic behavior, and this fact points strongly to its microbic origin. Hence local disturbances of the circulation due to exposure are to be regarded as the accidental means of preparing the soil for bacterial invasion. Tunncliffe has isolated an anaërobic Gram-negative bacillus (*Bacillus rhinitis*). Acute rhinitis was produced by experimental inoculation and by the organism recovered in pure form from those thus infected. Acute rhinitis may be also secondary to, or propagated from, inflammations of the faucial mucosa by contiguity.

Symptoms.—Sensations of *chilliness*, succeeded by *feverishness* (the temperature reaching 100° to 101° F.—37.7°–38.3° C.), frequent *sneezing*, *headache*, and a feeling of general ill-health are among the prominent features that attend the development of coryza. Pains in the extremities and back tend to appear only in severe cases. The pulse is frequent, the skin dry and unduly warm, thirst is increased, while the appetite is impaired, and constipation often attends. The *nasal mucosa* is swollen, and thus interferes both with the nasal respiration and the senses of smell and taste; its color is deepened, its surface covered at first with opaque mucus, and later with a mucopurulent secretion. Among early symptoms is the discharge of a watery, irritating secretion from the nares and a maceration of the epidermis, with resulting abrasions. On account of the swelling of the mucosa of the lacrimal ducts the tears flow down over the cheeks. Adjacent mucous surfaces may become involved, giving rise to conjunctivitis, catarrhal pharyngitis, laryngitis, and finally, in the severer types, bronchitis. Nasolabial herpes is not uncommon. As the affection progresses the secretion becomes more abundant and turbid and more or less pyoid. The symptoms due to extension of the catarrhal inflammation vary with the organs or structures involved. The disease runs its *course* within five or six days, but the nasal discharge, which gradually diminishes, usually persists for a few days longer.

Diagnosis.—In the presence of the above-mentioned symptoms the disease is readily recognized. In well-marked cases the possibility that an infectious disease may be developing, the beginning of which is characterized by nasal catarrh (measles), is to be recollected.

Prognosis.—Except in neglected cases, which result in bronchitis, and occur at one or other extreme of life, the disease is free from danger. The nursing infant may have to be fed with a spoon temporarily.

Treatment.—At the outset a purge, consisting of calomel (gr. ij—0.13), or a pill of blue mass (gr. v—0.3) at night, followed by a Seidlitz powder in the morning, is advisable. To children a dose of castor oil may be given. The early administration of a diaphoretic, such as Dover's powder (gr. v to x—0.3–0.6) at night may arrest the complaint, and quinin in a large dose (gr. xij to xv—0.77–1.0) at night, may cut short the course of the disease. When the above-mentioned abortive measures fail, the following capsule produces good results:

R. Extr. belladonnæ fol.,	gr. ss (0.03);
Quininæ sulph.,	gr. iij (0.20);
Camphoræ,	gr. iij (0.20);
Sodii salicylatis,	gr. xxx (2.00).

M. et ft. cap. No. x.

Sig. One every two hours.

For the fever aconite may be employed, and, if the throat be involved, bryonia may be given in conjunction.

Local Treatment.—This aims at soothing as well as at reducing the swelling of the schneiderian membrane. The compound tincture of benzoin forms a soothing inhalation (ʒij to a pint—8.0 per half liter—of water) when raised nearly to the boiling-point; the vapor is inhaled for ten or fifteen minutes at a time. With a view to reducing the swelling a solution of cocain (strength 2 to 4 per cent.) may be temporarily used; the following is an admirable combination:

R. Menthol,	gr. v (0.3);
Phenol,	ʒv (0.3);
Petrolati liquidi,	fʒj (30.0).

In severe cases the patient should be kept indoors and in an atmosphere of even temperature.

CHRONIC RHINITIS

(*Chronic Nasal Catarrh*)

Two forms are recognized—the hypertrophic and atrophic—and these, though, as a rule, occurring separately, may be found in combination.

Pathology.—The morbid changes in hypertrophic rhinitis consist in an enlargement of the lower turbinated processes, together with redness and swelling of the nasal mucosa that may be general or limited either to the anterior or posterior nares. As the disease progresses the thickening of the membrane increases, until it finally encroaches upon the nasal chambers at every point. In addition to the nasal obstruction there is a hypersecretion of mucus. Opposite changes occur in atrophic rhinitis, such as thinning or atrophy of all the structures, with enlargement of the nasal cavities. The nasal mucosa is coated with thick, yellowish-green, decomposing crusts, which emit a characteristically fetid odor, and the frontal, ethmoid, or other accessory

sinuses may, by an extension of the inflammation from the nasal chambers, be invaded by mucopurulent inflammation. The atrophic process does not affect the glandular structures of the upper third of the nose, and this fact explains the most unpleasant feature of the affection—namely, the horrible secretion.

Etiology.—Frequently occurring attacks of acute rhinitis may produce the chronic form, and syphilis and, less commonly, tuberculosis are also among its causes. Abel¹ regards atrophic rhinitis as infectious, claiming that the cause is the *Bacillus mucosis ozenæ*, which resembles closely the pneumobacillus, but is distinguishable from it. Perez and Hofer also hold to the same belief.

Symptoms.—(a) In the *hypertrophic* form nasal respiration is impeded, owing to the hypertrophy of the turbinated bodies. The sense of smell is impaired, and there is a discharge of secretion from the nares, particularly the posterior, inducing “hawking.” The diagnosis is set at rest by a rhinoscopic inspection of the parts. While this is a common affection everywhere, it is wellnigh universal in this country.

(b) In chronic *atrophic* catarrh there is some degree of nasal obstruction, occasioned by the presence of the thick crust, but the most conspicuous symptom is the disgusting odor, which makes the patient repellent in society. The sense of smell is lacking. After cleansing the membrane the rhinoscope will show the nasal chambers to be unduly capacious.

Treatment.—(1) **Chronic Hypertrophic Rhinitis.**—The treatment is divisible into *general* and *local*. The physician should procure an environment for his charge most favorable for promoting the general nutrition, which is often below the health standard. The selection of a suitable climate, then, forms an important part of the management, and a residence in a locality that possesses a mild, equable, comparatively dry and pure atmosphere is to be advised and encouraged. Various tonics may then be demanded by the general condition of the patient, and strychnin and electricity are useful in restoring the loss of power in the contractile elements of the intercellular walls.

Local measures are employed to facilitate thorough cleanliness and disinfection of the affected parts, though in incipient and mild cases energetic treatment is scarcely needful. The best method of cleansing the nasal passages is by means of the coarse spray. The apparatus of Lefferts is also to be employed when the secretion is inspissated or tightly adherent. An excellent combination for use in this manner is the following:

R.	Phenolis,	℥x (0.6);
	Sodii boratis,	
	Sodii bicarbonatis,	āā 3j (4.0);
	Liq. antiseptici,	f3j (30.0);
	Aquæ dest.,	q. s. ad f3iv (120.0).—M.
Sig.	Use as a spray three times daily.	

It is often desirable to use warm or even hot liquids, in which case the application is made by the use of the anterior and posterior nasal syringe. Powders are harmful, and, as the nasal douche is dangerous in unskilled hands, these should both be abandoned.

In hypertrophic rhinitis the obstruction to nasal breathing is to be removed, and to accomplish this caustics (chromic, glacial acetic, and nitric acids) are used, of which the most efficacious is chromic acid. This should be applied by means of a pointed glass rod, the application being followed by

¹ Zeit. f. Hyg. u. Infectiouskr., Bd. xxi. H. 1.

a sloughing away of the diseased tissues. Among other modes of removing the nasal obstruction that may be mentioned are the galvanocautery, the thermocautery, and the cold-wire snare; these modes, however, are practised chiefly by the specialist.

(2) In **atrophic rhinitis** a cure is to be despaired of, but the patient can be rendered free from the offensive discharge, and hence to a great degree comfortable. As this is often but an advanced stage of hypertrophic nasal catarrh, the general treatment is similarly directed; it is therefore well to overcome, as far as possible, by a mental stimulus, the depressed mental state due to the fetor. If the diathesis be tuberculous, cod-liver oil, iron, arsenic, and strychnin, together with a generous diet, are to be advised. If syphilis is associated, appropriate measures must be instituted. Moreover, since a subject of atrophic rhinitis is a fertile source of atmospheric contamination, his living and sleeping apartments must be highly ventilated.

Local Measures.—An antiseptic spray of Seiler's or Dobell's solution, and oiling the nasal cavities, are measures to be first tried. If they prove non-efficacious, the crusts may then be removed with a cotton applicator coated with a solution of hydrogen peroxid. We may then use a spray of liquid petrolatum and menthol; this serves not only to lubricate but to supply moisture both of which are important therapeutic indications. Small ulcerations occur in this affection and induce oft-repeated epistaxis; consequently, an attempt should be made to heal the latter and to obtain an even, moist surface. To accomplish this the method of Clarence C. Rice may be followed—*i. e.*, to rub the ulcerations thoroughly by means of a cotton-carrier with a small hard pledget of cotton moistened with alkaline antiseptic solution for a few seconds at a time. These antiseptic frictions are made at intervals of two or three days for two or three weeks. More recently vaccines have come into more or less general use, employing the *ozena bacillus* of Perez. The vaccines are given by the usual methods of vaccine therapy, except that they are continued over a long period of time.

AUTUMNAL CATARRH

(*Hay-asthma; Hay-fever*)

A type of protein poisoning (anaphylaxis) due to plant pollen sensitization in which the symptoms are those of catarrh of the upper air-passages and, at times, of asthma.

Pathogenesis.—Formerly supposed to be due to nervous influences, it has now been definitely shown that hay-fever is a manifestation of hypersensitization caused by the pollen of various plants, notably the ragweed, red-top timothy, rye, and golden-rod. When the special exciting pollen reaches the mucous membrane of the nose of sensitized individuals its proteins are split up, with the liberation of a product which has a special toxic effect upon that individual, manifested by the symptoms of hay-fever. It has been shown that heredity may have some relationship to the disorder in that there is often manifested an inherited tendency to sensitization by certain plants. Abnormalities of the nasal passages permit of more ready solution and absorption of the pollen. Sensitization is more likely to occur in young persons than old.

Symptoms.—The symptoms are (a) local and (b) general.

(a) **Local.**—Hay-fever has an *abrupt onset*, and the attacks return annually at or about the same time; that is, when the exciting pollen makes its seasonal appearance. The *invasion* is marked by pronounced coryzal symptoms, with much sneezing, stoppage of the nasal passages, copious rhinorrhea, the dis-

charge being watery as a rule, and rarely mucopurulent. Suffusion of the eyes, with itching of the lids and free lacrimation are constant features; the decided itching sensation of the palate and pharynx is also at times a distressing symptom. The sense of smell may be lost, and taste and hearing impaired.

The *course* as regards the local symptoms is marked by alternate amelioration and aggravation of the symptoms, the exacerbations being due to exposure to the open air, especially in changeable weather. Later the catarrhal process invades the bronchi, and cough and asthmatic seizures appear, these often becoming very distressing.

(b) **General disturbances** comprise subjective sensations—anorexia, insomnia, lassitude, and chilliness alternating with slight feverishness.

The *course* is from four to six weeks, and cases that develop in August are terminated by the occurrence of a decided frost, because the fall plants that cause the disorder are killed by the cold and hence no more pollen is produced. Wyman also describes the “rose cold,” which comes on in the spring.

Diagnosis.—The recognition of hay-asthma is unattended with difficulty, provided that such facts as the time of its occurrence and its annual periodicity are carefully noted. Goodale¹ has examined 58 cases giving a history of hay-fever for skin reactions, the pollens of ragweed and golden-rod giving the highest percentage of positive reactions.

Prognosis.—This is favorable as to life, though a permanent cure is a rare event unless permanent removal from the influence of the specific pollens or desensitization of the individual with vaccines prepared from these pollens can be effected.

Treatment.—Whenever possible the patient should travel until he finds a locality in which he ceases to suffer, and subsequently he should there spend the period of annual attack, and by these means escape the exciting causes. The Adirondacks and White Mountains usually bestow immunity. If unable to do this, the patient should avoid drafts, travel, or anything likely to blow the pollen to him. The windows should be kept closed at night and the clothes well shaken and removed in a room other than the sleeping-room.

The local symptoms demand the topical application of various agents to the nasal chambers, such as cocain hydrochlorate solution (1 per cent.): if applied on cotton with a probe, followed by a 4 per cent. solution of antipyrin, the palliative effect is prolonged (Gleason).

Of 1240 patients who used *serum-therapy* correctly, 56.1 per cent. either remained free from attacks, or could abort attacks already started (Dunbar). Hichens and Brown² advocate two vaccines, one in the spring, “a mixture of pollens from red-top timothy, rye, and orchard grass,” and another in the fall, the pollen of ragweed alone. Goodale³ begins immunization some ten weeks before the usual onset of symptoms. He employs rapidly increasing doses of pollen extract, controlling the dosage by the skin reaction. If the attack has already commenced he gives daily small injections, paying no attention to the skin reaction.

Atropin has been shown by Lewis and Auer to have a definite desensitizing effect. When given internally the dose should not exceed gr. $\frac{1}{800}$ (0.0002), to be repeated every hour until dryness of the throat appears. My best results have been derived from the hypodermic use of this drug (gr. $\frac{1}{800}$ —0.0003) at intervals of three to four hours until the desired effect is produced. Harold Wilson has obtained encouraging results from calcium chlorid taken in doses of 3 gm. (gr. xlv) daily, and Besredka has shown that this drug is most effectual in preventing hypersensitiveness.

¹ *Boston Med. and Surg. Jour.*, November 5, 1914.

² *Jour. of Lab. and Clin. Med.*, 1916, i, 457.

³ *Boston Med. and Surg. Jour.*, 1918, clxxix, 293.

EPISTAXIS

(Nosebleed)

Etiology.—The causes of nosebleed are various, and a convenient grouping is the following: (a) Affections of the nasal mucosa (*e. g.* ulcer, polypi, intense hyperemia). (b) Injuries, either external, as from a blow, or internal, as from plugging with a foreign body, nose-picking, etc. In this category may also be included epistaxis due to fracture at the base of the skull. (c) Acute infectious fevers, particularly typhoid (at the onset) and influenza. (d) Chronic disorders of the blood, such as pernicious anemia, leukemia, and hemophilia. (e) Vicarious menstruation. (f) Rarefaction of the air. (g) Plethora; here may be mentioned cerebral congestion. (h) Severe overexertion, particularly in arteriosclerotics. (i) Frequent epistaxis may be caused by high blood-pressure, as in chronic interstitial nephritis. (j) Sclerosis of the postnasal blood-vessels in generalized arteriosclerosis.

Symptoms.—Except when due to traumatism the blood usually drops slowly from one and occasionally from both nostrils. Rarely, the blood may flow as a continuous stream or the nares may present a projecting coagulum. The blood may also gravitate into the pharynx and be coughed up, or it may be swallowed and vomited. A rhinoscopic examination often reveals the source in cases in which a previous diagnosis of hemoptysis or hematemesis has been made.

The immediate results of nosebleed are weakness and a moderate anemia, but these are not prolonged, as a rule. Cases arising from fracture at the base of the skull will generally prove fatal, and rupture of a sclerotic vessel may cause at times fatal hemorrhage.

Treatment.—A careful search for a local cause is especially demanded in cases in which there are frequently recurring attacks. In most cases a spontaneous arrest occurs, but if not, a resort to simple household measures, such as the application of ice to the nose or to the back of the neck, holding the hands up, or the injection of very cold or very hot water into the nares, are to be encouraged. Various astringents (tannic acid, acetate of lead, alum, zinc) may be employed, and a saturated solution of antipyrin is also highly praised. Adrenalin chlorid is valuable. When an ulcerated bleeding-point can be reached, there may be applied to it a solution of chromic acid or it may be cauterized by solid silver nitrate. Prolonged pressure applied upon the facial artery as it passes over the inferior maxilla may be efficacious. A solution of gelatin may be injected into the nostril. I have no confidence in internal astringent remedies. In obstinate cases the posterior nares should be plugged, preferably with gauze lubricated with oil or petrolatum, to avoid recurrence when packing is removed. Tincture of aconite or nitroglycerin may be used in arteriosclerotic conditions. In the blood dyscrasias blood-serum, normal horse-serum, or even transfusion in intractable cases are the remedies of proved value.

piece of rubber tubing may be attached to the end of the funnel that is uppermost.

Steam atomizers admirably meet the necessities of the case; and in the case of children the vapor benzoin, eucalyptol, and other equally sedative and stimulating substances may be diffused in the air of the sick room. Concentrated solutions or insufflations of powders are not without harmful influ-

Fig. 43.—Method of making a laryngoscopic examination.

The patient is placed in front of the operator, on an arm-chair, with the back of the chair high enough to afford him head a comfortable rest, and with the source of the light over the right shoulder. The operator then adjusts the head-mirror (the fixed apparatus), warms the throat-mirror over a light sufficiently to prevent the moisture of the breath from being deposited upon it, and touches the hand with the mirror when passing it into the mouth, so as not to use it too hot. The patient's tongue is then protruded, and by means of a napkin is seized between the thumb and the forefinger and drawn well forward to lay the larynx held in the right hand in the same way as one holds the handle being inclined downward and outward, its shaft is then passed backward without altering this relation to the palate, the shaft of the mirror in this movement striking the uvula. The subsequent movement consists in turning the mirror until it is inclined at an angle of 45 degrees to the line of vision, until the uvula rests upon its posterior surface, when its edge comes entirely into view again and rests firmly against the epiglottis, and exposes and brings into view the

larynx kept in the median line, with its plane always at right angles to the line of vision. In making a laryngoscopic examination we must be careful to keep the mirror at a natural being a rose-pinkish tint), of the outline of the vocal cords, if any, etc.

case, and neither the cotton-carrier nor the mop should be allowed to enter the larynx in this affection. The external application of the ice-bag or cold compress tends to mitigate the inflammatory process and to obviate spasm.

The *general* treatment differs with the special stages of the complaint. If the case is seen early, a full dose of quinin (gr. xij to xv—0.8–1.0) may serve to successfully abort the attack, and in conjunction Dover's powder (gr. v to x—0.3–0.6) may be prescribed. Codein sulphate may be given at prolonged

stimulating atmosphere, and I have found that in many cases the selection of a proper climate constitutes the most important part of the treatment. (b) The *medicinal* treatment is both local and general. The latter should include creasote, cod-liver oil, and other tonics. Expectorants are of little if any value. The *local* measures, however, are important. Moderate exposure of the neck and daily ablution with cold water are to be advised, and attention to the nose and nasopharyngeal cavity is of prime importance.¹

A long list of applications to the larynx from within, including local astringents, disinfectants, and alcoholics, might be enumerated. Of astringent solutions, however, the best are tannic acid (1 to 2 per cent.) or alum (0.5 to 1 per cent.) and zinc sulphate (3 to 5 per cent.). These may be sprayed into the larynx by means of a compressed-air machine with spraying tubes, although all of the different kinds of inhaling apparatus more commonly used will answer the purpose. If the ordinary hand atomizer be used, the patient should be taught to draw the vapor into the larynx by gentle and frequent acts of respiration. Disinfectants, such as creasote, potassium chlorate (the latter if ulcerations be present) in solutions of suitable strength, may be used in like manner. I can confidently advise as useful applications both iodine and silver nitrate, commencing with a weak solution of the latter (gr. v to ʒj—0.3–4.0), and the strength being gradually increased until the maximum strength that can be endured without distress is reached (gr. xx to ʒij—1.3–8.0). These topical applications should be made directly with a cotton-carrier or brush at intervals of three or four days, preceded by the use of a cleansing spray. The many astringent and sedative lozenges found on the market are only slightly palliative in their effects, and their prolonged use tends to excite gastric disturbance. I am unalterably opposed to the insufflation of powders, believing that they are capable of augmenting the laryngeal irritation and of adding fresh irritation in adjacent parts, particularly in the tracheobronchial tract.

SPASMODIC LARYNGITIS

(*Laryngismus Stridulus*; *False Croup*)

Definition.—An affection peculiar to children, chiefly of nervous origin, though also, according to Strümpell and others, often associated with acute catarrhal laryngitis.

Etiology.—The affection is almost solely limited to children between six months and five or more years of age. It is sometimes excited by strong passion or emotion, and it may be associated with tetany. Rachitic subjects are peculiarly liable. The causes of spasmodic croup are in great part those of acute laryngitis.

The mode of action of the direct causes is unknown, but the spasm of the adductors that causes the urgent dyspnea is probably reflex and due to peripheral irritation.

Symptoms.—Two clinical varieties are to be distinguished: (1) That in which the larynx is free from catarrhal inflammation, or the *purely nervous type*. This is especially characterized by sudden brief attacks of dyspnea, either by day or night (often on awakening), that terminate in a high-pitched crowing inspiration ("child-crowing"). The face during the spasm is cyanotic. General convulsions have been noted, but there is neither cough, fever, nor hoarseness. The attacks may be frequently repeated within a single day.

¹ J. C. Wilson's *Amer. Textbook of Applied Therapeutics*, p. 791.

the habit of giving small doses of the bromids thrice daily, together with warm cod-liver oil inunctions, with striking effect.

2. In spasmodic croup an emetic is to be given at once, the best being a mixture of alum and syrup of ipecac, of which the dose is 3j (4.0), to be followed by irritation of the fauces with the finger in order to facilitate emesis. In severe paroxysms a hot bath may be given to aid the emetic. In case the dyspnea is not checked by the above measures, chloral hydrate may be exhibited by enema (gr. ij to v—0.13–0.3) or a whiff of chloroform may be given. The local application of cold (ice-collar, ice-water cloths) is useful, and sinapisms placed around the throat and over the chest also tend to arrest the spasm. The use of steam inhalations from the so-called croup kettle (Fig. 44) is of signal service, and should be more widely employed, particularly when it is inconvenient to use the hot bath.

Between the paroxysms the patient should receive a mild laxative, such as calomel or castor oil, and, in addition, the treatment appropriate in acute catarrhal laryngitis. To prevent recurrences an environment calculated to increase the nervous tone of the child is to be procured, and it is especially advisable to accustom him to the outer air, though protected by suitable dress and without undue exposure to drafts.

EDEMATOUS LARYNGITIS

Definition.—An infiltration of the mucous membrane of the larynx with serum. In most cases it is a true inflammatory edema.

Etiology.—Two chief classes of causes are operative: (1) Those that excite inflammation. The condition may complicate acute laryngitis, though oftener it appears in chronic affections of the larynx, and particularly if ulceration be associated (*e. g.*, tuberculosis, syphilis); it may also appear in connection with certain infectious diseases (erysipelas, diphtheria, typhoid fever). The inflammation inducing the edema may extend from adjacent parts, as the neck, pharynx, and other organs. (2) Factors that tend to excite dropsical effusion. These may be general, as Bright's disease, heart affections, angioneurotic edema, etc., or they may be local. Among the latter are enlargements of the cervical and mediastinal lymphatics, aneurysm of the arch of the aorta, thyroid tumors, etc.—*i. e.*, conditions that exercise pressure upon the jugular veins. Rice, who studied 14 cases, thinks it doubtful whether edema of the larynx ever occurs from simple catarrhal inflammation.

Symptoms.—In acute cases the initial disturbance is both sudden and severe. There is *dyspnea* that tends to increase rapidly, accompanied by a husky, suppressed voice, with augmenting obstruction. The *respirations* may become stridulous, but there is no cough. The laryngoscope reveals marked swelling of the epiglottis and of the aryepiglottic folds. Rarely the swelling occurs in or even wholly below the vocal cords. The inserted finger may detect the swollen epiglottis, which may also be seen if the tongue-depressor be used.

Diagnosis.—This can be made with ease from the rapidly developing dyspnea soon reaching the climax, the absence of cough and hoarseness, and by the use of the laryngoscope. In cases in which the epiglottis can be felt or seen a laryngoscopic examination is superfluous.

The **prognosis** is decidedly unfavorable except in the event of early operative interference.

Treatment.—If of inflammatory origin, the ice-bag should be applied to the larynx, and ice should be allowed to constantly dissolve in the patient's mouth. Local depletion, preferably by leeching the front of the neck, is also to be tried, and Levy and Laurens¹ record a case in which a cure followed this measure. If intense dyspnea tends to persist, scarification of the edematous parts with a curved bistoury, the point of which is covered with adhesive plaster, must be promptly instituted, and, if asphyxia threatens, tracheotomy or intubation must immediately be performed. Dropsical edema demands scarification and, if relief does not follow, intubation or tracheotomy.

TUMORS OF THE LARYNX

These may be either benign (fibroma, myxoma, lipoma, chondroma, adenoma, angioma, cyst) or malignant (sarcoma, carcinoma). Of these, papillomata or papillomatous fibromata occur most frequently, especially in infancy. Navratil records 42 cases of multiple laryngeal papillomata in children whose larynges were extensively filled. Those growths may also occur in chronic laryngitis, and, like other tumors of the larynx, they commonly spring from the vocal cords. Their shape, size, and tendency to pedunculation do not differ from their characteristics when noted elsewhere in the body.

Symptoms.—Small tumors may occupy the larynx without producing symptoms. The first feature then noted is *hoarseness*, which gradually grows worse and may end in complete aphonia. If situated in the upper larynx, *cough* is common, and when the tumor causes obstruction of the larynx *dyspnea* supervenes and tends to increase in severity. A mobile growth may cause sudden occlusion of the glottis, exciting orthopnea and threatening asphyxiation. To confirm the diagnosis a laryngoscopic examination is required.

The **prognosis** is favorable in the benign, but unfavorable in the malignant forms.

Treatment.—This is altogether surgical, though Delavan states that 3 cases of papilloma have been cured by frequently repeated sprays of absolute alcohol. Curetting is often followed by a recurrence, while laryngofissure and thorough removal of the growths restore speech and prevent recurrence.

III. DISEASES OF THE BRONCHI

CATARRHAL BRONCHITIS

(*Tracheobronchitis*)

Definition.—A catarrhal inflammation of a part or the whole of the mucous membrane of the bronchial tubes. The mucosa of the trachea is also involved to a greater or less extent, and hence the term "tracheobronchitis" is quite appropriate, being descriptive of the seat and character of the disease. Involvement of the bronchioles may also take place, but not without an involvement of the corresponding alveolar structure, the condition being then, with propriety, termed "bronchopneumonia." Hence the term "capillary bronchitis," still often employed to describe the latter condition, is not pertinent. A certain class of cases is met with, however, in which the catarrh

inflammation, as the result of downward extension, implicates the smaller bronchial tubes without involving the bronchioles; to such the term "capillary bronchitis" might be appropriately given.

The disease may be acute or chronic, both of these forms occurring either as a primary or secondary affection.

ACUTE BRONCHITIS

Pathology.—The portions of the mucous membrane of the trachea and bronchi that are implicated become reddened and swollen; they are covered with mucus mingled with epithelial cells, and later mucopus. Some of the smaller bronchial tubes are dilated. The mucous glands are swollen.

The histologic changes may be briefly stated as follows: desquamation of the ciliated epithelium, edema and swelling of the submucosa, and, in the severer grades, infiltration of the latter with leukocytes.

Etiology.—With rare exceptions tracheobronchitis is produced by the extension of a catarrhal inflammation from the nares, pharynx, and larynx. Rarely the bronchi are the seat of primary acute catarrh, and in the latter instances the upper air-passages may be implicated secondarily, constituting a reversal of the direction of extension.

The immediate causes are mechanical, chemical, and biologic irritants, which act directly upon the tracheobronchial mucosa; and that bronchitis is frequently due to infection at a time when the resisting power of the system is low there can be little doubt. Among organisms commonly met with is the so-called *Micrococcus catarrhalis*. Wolf and Spehl¹ describe a bronchitis due to an unidentified spirochete which was abundant in the sputum. The circumstances disposing to bronchitis are many, those pertaining to the individual being—(1) Age, the old and very young being most liable. (2) Debility. (3) Occupation, as in certain trades that expose to irritating vapors and sedentary pursuits. Among the external conditions are: (a) Climatic factors, particularly variability of temperature and humidity. (b) Seasons of the year. "Catching cold" often results from exposure during the spring and autumn months. These two conditions depend substantially upon the same factors. (c) Epidemic influence, which may be independent of influenza. (d) Severe contusion of the chest.

Acute tracheobronchitis arises as a secondary condition in a great variety of diseases, as, for example, the exanthemata and other acute infectious diseases (typhoid fever, measles, whooping-cough, influenza, etc.). As shown elsewhere, among this class of diseases the bronchitis may be dependent upon the primary infectious process; but in many others it is due either to the inhalation of pathogenic irritants or to the retention of bronchial secretions that are apt to accumulate and decompose with resulting bronchitis. The accidental inhalation of particles of food and saliva may also lead to secondary bronchitis, or the condition may be secondary to chronic affections—e. g., Pott's disease, gout, Bright's disease. Among the toxic causes the poison of uremia must be embraced.

Symptoms.—Bronchitis of the larger tubes, which extends down to about the second division of the bronchi, is spoken of usually as a "cold." In such cases the onset is marked by recurring sensations of *chilliness*, and by *coryza*, slight *sore throat*, and *hoarseness*; while in young and feeble children *convulsions* may occur early. Mild *febrile symptoms* may appear, the temperature ranging from 101° to 103° F. (38.3°–39.4° C.), with slight acceleration of the pulse; and there may be languor and aching in the limbs and lumbar region. With the fully developed attack substernal soreness, sometimes even *pain*, is experienced, especially on coughing, and the pain may be referred to the

¹ *Arch. mèd. Belges*, July, 1918, p. 1.

an any other type of foreign body which may enter the trachea. The condition is extremely unlikely to be confused with the ordinary types of bronchitis; in fact, the symptoms are more closely allied to those of a tracheal stenosis or of a septic pneumonitis.

The prognosis varies with the previous constitutional state of the individual. In healthy adults, after a period ranging from a few days to two weeks, the fever subsides, but the cough, though less marked, and the expectoration usually continue for a variable length of time. In old persons and in those of a gouty or tuberculous diathesis the cases pursue a more protracted course. The cases in which streptococci are found in the sputum are severe and in the old may prove fatal. There is in these subjects a tendency on the part of the catarrhal process to extend downward until the finer tubes are implicated, sometimes endangering life. In the old the secretions are imperfectly expectorated; they gravitate to the most dependent parts and induce bronchiectasis. In young children this downward extension of the affection, with resulting bronchopneumonia and areas of collapse in consequence of dilatation and occlusion of the bronchioles by mucopus, is a not uncommon and serious event (*e. g.*, in measles, whooping-cough, *vide Bronchopneumonia*).

Treatment.—There are many instances in which but little treatment is required apart from the usual household measures and protection against cold and damp. If seen early, while the coryza is present, the attack may often be aborted by the use at bedtime of a Dover's powder in combination with quinin (gr. iv to viij—0.25–0.5); this may be seconded by a glass of hot lemonade, with or without a portion of whisky, and either a hot bath or a mustard foot-bath. The following morning a saline laxative should be taken. To children a mild calomel purge followed by a dose of castor oil may be administered. The patient should be kept in a warm, moist, equable atmosphere—preferably indoors—and during this period he should take divided doses of quinin for a day or two. If the above mode of treatment fail or if the patient does not come under observation early, the main objects of treatment should be (*a*) to render the secretions free, and (*b*) to hasten the expulsion of the sputum after it has been loosened. The first leading indication is to be met by the use of diaphoretics, diuretics, and relaxants. The subjoined formula combines these classes of agents:

R. Potassii citratis,	3vj (24.0);
Vini ipecacuanhæ,	f3ij (8.0);
Spir. ætheris nit.,	f3j (30.0);
Liq. ammonii acet.,	f3v (150.0);
Aq. dist.,	q. s. ad f3viij (240.0).—M.

Sig. Tablespoonful in water every two hours until secretions are loosened.

If the temperature in any given case be maintained at a considerable elevation, such as 102° to 103° F. (38.8°–39.4° C.) or over, tincture of aconite (xxv—1.0) may be added to the above mixture; and if there be present much tickling with distressing cough, due to irritability of the affected mucosa, codein (gr. ij to iij—0.13–0.2) may be added to the same. For the incessant irritative cough which is present in severe forms of catarrh opium alone is really effective. When the above prescription is not productive of free secretion and troublesome cough continues, I employ the following:

R. Codeinæ sulph.,	gr. iv (0.26);
Ammonii chloridi,	3v (20.0);
Mist. glycyrrh. co.,	q. s. ad f3iv (120.0).—M.

Sig. Teaspoonful in water every two hours.

by certain chronic complaints and certain diatheses, as chronic alcoholism, rheumatism, gout, syphilis, pulmonary tuberculosis, and pulmonary emphysema. Organic valvular affections, obesity, and chronic Bright's disease cause *hypostatic bronchitis*. The primary form, which is rare, is the result of exposure to wet or cold or to the daily inhalation of some irritant that maintains a low grade of catarrhal inflammation (dust, vapors). *Pyorrhea alveolaris* "is a most potent factor" (Shivdas). When chronic bronchitis follows the acute form we are often able to detect the operation of some favoring cause, as age, climate, or season. It is most common in the aged, and occurs by preference during the cold season, often recurring regularly in the cold and variable weather of autumn and winter, and disappearing in summer. Hoxie and Lamar report 2 cases of tracheobronchitis due to the presence of fungous stalks as the only causative agent.

Symptoms.—The symptoms are similar to those of acute bronchitis, though rather less severe. *Pain* is rarely present, the patient complaining merely of a feeling of substernal constriction. There may be soreness at the base of the chest if the cough be frequent and severe, and occasionally in the epigastrium as a result of traction of the diaphragm on the ribs. *Cough*, while not a constant accompaniment, is *paroxysmal* and varies in severity and frequency. The degree of the violence of the paroxysm depends upon two factors—the character of the bronchial secretion and the seat of the catarrhal inflammation. Thus when the expectoration is tenacious and scanty, and when the small-sized tubes are affected, cough is most violent. It also varies both with the weather and the season, as is evident from the fact that there is often an absence of cough in summer, while it returns unfailingly with each new winter.

The *expectoration* differs widely in different cases. It is sometimes abundant and seromucous in character. On the other hand, there are cases of dry cough in which there is little or no expectoration. As a rule, however, it is rather copious, and either *mucopurulent* or distinctly *purulent* in character. *Fever* is usually absent, though rarely a slight rise of temperature occurs at night. The appetite is good as a rule; the bodily weight and nutrition are also well maintained.

Physical Signs.—On *inspection* we usually note undue enlargement of the thorax, with a decrease in expansile movements due to the associated emphysema. Hence *dyspnea* is commonly observed.

Percussion yields a clear or hyperresonant note. Dulness or impaired resonance is sometimes met with, however, during acute exacerbations, especially over the bases, and is due to congestion and edema (Fox). On *auscultation* rhonchi of various forms and moist râles are heard, their number and size being in proportion to the extent of the swelling of the mucous membrane and the amount and fluidity of the secretory products. The respiratory murmur is enfeebled, though roughened, and the expiratory sound is prolonged and wheezy. The right heart may be dilated from increased tension in the pulmonary circuit.

Clinical Varieties.—Special forms, depending largely upon specific causal factors, remain to be described:

1. The commonest variety of chronic bronchitis has been called the "winter cough of the aged," and, as before intimated, is usually accompanied by emphysema and cardiac disease. The cough occurs in paroxysms that are most severe at night, and during the early morning hours it is attended with free expectoration of the secretion that has accumulated during the night.

2. *Bronchorrhea*.—In this form there may be an abundant bronchial secretion, composed largely of serum (*bronchorrhea serosa*). More frequently perhaps the expectoration is purulent and thin, containing greenish or greenish-

stration constitute a group of features that should distinguish it from chronic bronchitis. Coexisting *pulmonary emphysema* is to be recognized by the characteristic symptoms and signs of this complaint. *Primary fetid bronchitis* must be differentiated from the various other conditions previously mentioned, giving fetor of the sputum and breath. In *abscess* of the lung the sputum contains shreds of lung tissue, including elastic fibers, crystals of hematin, cholesterolin, and amorphous blood-pigment; usually localized dulness and bronchocavernous breathing coexist. In *gangrene* there are contained in the sputum shreds of lung tissue, but separate elastic fibers are often absent, on account of the presence of a ferment that causes a solution of the elastic tissue (v. Jaksch). *Bronchiectasis* is usually unilateral and gives rise to dulness and other physical signs that are confined to limited areas, while in chronic bronchitis the signs are general.

Prognosis.—Recovery is the exception, though improvement may frequently be observed. The course is exceedingly protracted, and the danger from the late development of certain complications and sequels, such as emphysema or right-sided cardiac disease, must be borne in mind. Since the disease is generally a secondary affection, the prognosis in most instances depends upon the outlook in the primary disease.

The treatment falls naturally under two main heads—(1) Hygienic, and (2) Medicinal.

1. *Hygienic.*—This has reference, frequently, to the removal of various noxious influences. When the patient cannot make a suitable change of air during the cold season, he must keep his room during inclement weather; he should, however, be allowed to spend as much time as possible in the open air during clear and pleasant weather. The vitiated atmosphere of saloons or public halls is to be avoided. The patient should wear flannels next to the skin during all seasons of the year, but his outer clothing need not be unusually cumbersome. If the case be of an aggravated type and the circumstances of the patient permit, he should be sent to a warm latitude in the autumn, in order to escape the effects of a severe northern winter. Patients in whom the bronchial secretions are abundant should be sent to a dry, warm climate or to a region whose atmosphere is impregnated with the balsamic vapors of the pine. On the other hand, patients with dry bronchial catarrh are most relieved by an equable, moist, warm climate. Among suitable resorts are: the Riviera, Cannes, San Remo, Sicily, and Algiers abroad, and Florida, Southern Georgia, and Southern California at home. Change of air may also become an effective means of prevention.

Prophylaxis also includes the removal of any diseased conditions that are etiologically related. The coexistence of cardiac disease, gout, obesity, and particularly any renal disturbance call for the primary treatment of these conditions. Hardening (*Abhartung*) is an important preventive method, and is accomplished by hydropathic measures—the cold sponge, douche, or plunge—if there be no contraindications.

The diet should be generous, and articles easy of digestion should be selected. Wines and liquors are to be avoided unless particular indications for their use exist. Special conditions, however (*e. g.*, albuminuria), may render necessary a special dietary. Restriction of the intake of fluids has given good results in cases attended with bronchorrhea.

2. *Medicinal.*—In this disease medicines are palliative in their effects rather than curative. Relaxing expectorants are to be avoided owing to their depressing action, and the stimulating expectorants are, in a majority of cases, not only valueless, but hurtful, tending to lessen the appetite and disorder the digestion. When, however, the sputum is mucopurulent and is dislodged with difficulty, expectorants of this class (squills, senega, am-

may be general or partial, the former variety being always unilateral, the latter sometimes bilateral. In *universal bronchiectasis* the bronchial tubes, throughout their extent, are the seat of numerous sacculi communicating with one another. These present smooth, shining walls, except in the most dependent parts, where ulcers may be seen. Extreme conditions of dilatation may take the form of huge cysts, which may extend to the periphery of the lung; the lung tissue lying between the sacculi then becomes cirrhotic as a rule. In *partial dilatation* the bronchial mucous membrane is implicated, with an occasional narrowing of the lumen. Usually these dilatations are cylindric, though they may be saccular, and rarely fusiform. The partial is the most common variety.

Histology.—When the walls of the larger dilatations are examined microscopically the cylindric epithelium is seen to be replaced by a pavement epithelium. The elastic and muscular layers are thin and the fibers are usually separated. Contained in these dilatations are found secretions that may frequently be fetid.

Etiology.—In the majority of instances the condition doubtless arises from an involvement of the bronchial mucosa that extends to the submucous tissue and leads to muscular, fibrous, and cartilaginous atrophy. These changes render the wall of the tube unable to resist the pressure of the air in the violent inspiratory effort of coughing, and, once the process of dilatation is commenced, the accumulated secretions may tend by their weight to distend further the already weakened walls. Thus the elasticity of the latter is impaired, and finally destroyed. The etiologic factors show the affection to be *secondary* as a rule, and are: (1) Chronic bronchitis and emphysema, chronic phthisis (usually when the seat of the dilatation is at the apex) and bronchopneumonia (in children). Heubner believes that bronchiectasis in adults may be sometimes traced to whooping-cough and measles in children. (2) Great thickening of the pleura, especially when associated with bronchitis or interstitial pneumonia, with contraction of the lung. (3) Rarely it is congenital. (4) Syphilis of the lung. (5) Obstruction to expiration, as by an aneurysm pressing on a bronchus, as by the sticky mucoid secretions in chronic bronchitis, or possibly, as suggested by Hoffman, by the kinking of the weakened bronchus.

Among predisposing conditions are—(a) *Age*, bronchiectasis being most common in adult or middle life; and (b) *Sex*, being more common in males than females.

Symptoms.—There is always *cough*, usually in prolonged and severe paroxysms. The attacks take place most generally in the morning when the dilated tubes are full, and may be excited by a change of posture. Accompanying the cough there is *profuse expectoration*, which may amount to a pint or more in twenty-four hours. The sputum is grayish-brown in color and mucopurulent, emitting a sour or, more frequently, a horribly *fetid odor*. On standing, the expectoration separates in three strata—the uppermost, of brownish froth; the middle, of a thin, seromucous fluid; and a thick sediment, of cells and granular debris. Examined microscopically, the sediment is seen to be composed chiefly of pus-corpuscles, with which are intermingled Charcot-Leyden and fatty acid crystals, the latter arranged in bundles; leptothrices, vibrios, and bacteria are also found. Elastic fibers may be observed if ulcers be present. In the apical form, which is rare, an absence of fetid sputum, due to the fact that drainage is more thorough in upper lobe cases, is to be noted (McCrae and Funk).

Dyspnea is noted, but is not a prominent symptom, unless some other chronic affections of the chest coexist or some complication arises. *Hemopty-*

sis occurs rarely, and may be due to the bronchiectatic lesion. Abscess of the brain may develop, though rarely.

Physical Signs.—These differ in character according to the size, situation, and nature of the dilatation, and also according to the condition of the surrounding lung tissue.

On *inspection* retraction of the chest wall may be noted when chronic pleurisy and interstitial pneumonia are associated. The respiratory excursion is diminished. The tactile fremitus is usually increased, but may rarely be diminished. The *percussion* resonance is impaired or even flat, and on *auscultation* bronchial breathing is heard, with occasional râles that have a metallic quality. In Pottenger's estimation¹ the absence of râles is a valuable sign in differentiating the condition from a tuberculous process. A *saccular dilatation* immediately beneath the pleura may give a tympanitic note, and may also give typical cavernous or amphoric respiration. A tympanitic resonance over a circumscribed area, which prior to cough and expectoration presented dulness, is a significant sign (Babcock). These signs are generally discoverable at the base of one or other lung.

Diagnosis.—Simple dilatation of slight degree may exist without appreciable signs, and in other instances the breathing is bronchovesicular over localized areas, with râles displaying increased metallic quality. The Roentgen ray is often of value in determining the location, size, and number of bronchiectatic cavities.

SACCULAR BRONCHIECTASIS

History of chronic bronchitis, chronic pleurisy, and interstitial pneumonia, or of foreign body.

Cough is paroxysmal, and sputum characteristic and copious.

Tubercle bacillus absent.

Course longer, with little impairment of the general health.

PULMONARY TUBERCULOSIS

History of cough, hemoptysis, with progressive loss of flesh and strength. Family history.

Cough less paroxysmal. Sputum nummular in the stage of cavity.

Tubercle bacillus present.

Course relatively shorter, powers of the system progressively undermined.

Physical Signs

The condition is persistent, but non-progressive. Usually located at base.

More apt to be progressive, commonly at one or other apex.

Circumscribed empyema with a fistulous connection with the lung may simulate bronchiectasis. There is often in such cases a clear history of an acute illness with a sudden onset, the symptoms pointing to pleural inflammation. The patient suddenly expectorates, at irregular intervals, large quantities of purulent matter. *Actinomycosis* may also cause conditions that simulate bronchiectasis. The diagnosis may be made by finding granular particles containing the actinomyces in the sputum.

Prognosis.—Apart from certain remote dangers (*e. g.* abscess, gangrene, fatal hemorrhage from an aneurysm in the wall of the cavity), these cases pursue a favorable but exceedingly long course.

Treatment.—The lesion being a permanent one, there is no known remedy that will either abridge or influence the course of the affection. Again, since the cough is protracted and attended with profuse expectoration, sedatives and ordinary expectorants are contraindicated. For the fetor, antiseptics are to be employed both topically and internally, and a solution of carbolic acid (1 to 3 per cent.) or thymol (1 : 1000) is to be used by inhalation. Internally, terebene (℥v to x—0.3–0.6) in capsules every four hours is valuable; also creasote, for its supposed pulmonary antiseptic properties, in increasing doses (℥j—0.065, increasing by ℥j each day, until ℥vj—0.4—are taken three

¹ *Amer. Jour. Med. Sci.*, 1919, clviii, 502.

times daily) is recommended. Intratracheal injections are often resorted to with gratifying results. By raising the foot of the bed we favor the discharge of the accumulated secretions from the sacculations, and it has been recommended to keep the patient in this position for long periods of time. Hoppe-Seyler advises this continuous postural method in cases in which no contraindications exist. The *diet* should be supportive, and Singer advises a reduction of the intake of fluids.

If the dilatation is situated superficially and not amenable to therapeutic measures, it may be freely opened and thoroughly drained.

BRONCHIAL STENOSIS

Definition.—Narrowing of the bronchus, due either to constriction or to compression.

Pathology and Etiology.—(a) *Stenosis Due to Constriction.*—This form is most frequently occasioned by the presence of foreign bodies; by new growths (polypoid) within the bronchi, or the cicatrices of healed ulcers, and in the smaller bronchi by swelling of the mucosa. The bronchial walls also sometimes become thickened by inflammatory exudates in certain acute and chronic affections, such as syphilis, tuberculosis, and glanders.

(b) *Stenosis Due to Compression.*—Compression of one or more bronchi may be met in enlargements involving the thoracic organs, *e. g.*, aneurysm, echinococcus cyst, solid tumors, enlarged glands, mediastinal and pulmonary abscesses, and pleural effusion.

The **symptoms** depend upon the size of the bronchus affected and the degree of stenosis. *Dyspnea* is the most conspicuous symptom, but the proper filling of the lungs with air is not accomplished. Under these circumstances the air in the lungs becomes rarefied, and instead of normal expansion the lower part of the sternum and the lower ribs are *retracted* on inspiration. Obstruction of the primary bronchus on either side of the chest would naturally be followed by inspiratory retraction of the inferior part of the chest wall and intercostal spaces upon the affected side. The movements of the larynx are slight in bronchial stenosis, while they are marked in laryngeal obstruction. *Cough, expectoration, and fever* are sometimes present.

Physical Signs.—*Inspection* shows defective respiratory movement upon the side involved. The local tactile fremitus is diminished or absent upon the affected side. The *percussion-note* remains unaltered, though less influenced by forced respiration, and particularly expiration, than in health. Pulmonary atelectasis may occur as a secondary event, and is shown by dulness on percussion. The *auscultatory* signs consist of a greatly diminished vesicular murmur on inspiration, due to the diminished amount of air entering the air-cells, and the presence of râles, sibilant and sonorous, at the seat of obstruction. Obstruction of a small bronchus may, however, be present without appreciable physical signs, owing to collateral emphysema.

Diagnosis.—The nature and site of the affection may be determined by auscultation, and sibilant and sonorous râles will be conspicuous at the point of constriction. A clear history, together with a careful investigation of antecedent affections of the thoracic organs leading up to the stenosis, are factors that must furnish the etiologic data in individual cases after the exclusion of foreign bodies as the possible cause. Tracheal or laryngeal stenosis may be eliminated by careful laryngoscopic examination.

Prognosis.—The duration is indefinite, though usually protracted, and most cases yield an unfavorable prognosis. In those instances, however, in

dulness, diminished vesicular murmur, and, in the higher grades, bronchial breathing, with liquid bubbling râles.

The **prognosis** is based upon the character of the underlying affection.

Treatment.—This is an affection in which the treatment of causes alone will suffice, save in instances secondary to organic heart affections, in which prompt bleedings are to be advocated. From a pint to a quart of blood should be taken, and I have seen happy results from the employment of this measure in extreme cases. Tapping the right auricle when the blood refuses to flow from an arm vein has been successfully accomplished by competent surgeons. The patient's posture must be changed from the dorsal to the lateral, and even ventral, and as soon as possible he should be gotten out of bed.

PULMONARY EDEMA

(*Edema of the Lungs*)

Definition.—An effusion of serous fluid into the air-vesicles and interstitial lung tissue. Pulmonary edema is scarcely to be regarded as an independent affection, but as a secondary condition, being in most instances associated with pulmonary congestion.

Pathology.—It consists of a transudation of serum into the alveolar walls, interstitial connective tissue, and air-cells. Rarely the process is limited to the interstitial tissue. Two forms may, for the sake of convenience, be recognized:

(a) **COLLATERAL EDEMA** (*Inflammatory Edema*).—This is usually local in character, circumscribing an area of the lung affected by pneumonia, abscess, or pulmonary infarction, and is the result of a mild inflammatory process affecting the vessel walls. When the condition follows hypostatic congestion the terms "hypostatic edema" and "splenization" have been applied.

(b) **GENERAL PULMONARY EDEMA.**—If congestion be not associated, the portions of the lungs involved look pale; when pulmonary congestion or pigmentation of the tissue is present, the lung appears darker than the normal and the serum is blood tinged. The weight of the lung tissue, owing to the more or less airless condition of the alveoli, is increased, and yet, though heavier than the normal lung, the affected tissue does not sink in water. To the feel it is boggy, and pits on pressure, while on section a serous or serosanguinolent (if congestion be present) fluid of low specific gravity, and poorer in albumin than plasma, flows from the cut surface. Edema is most frequently observed at the bases of the lungs, though it may become general. Hydrothorax may be present.

The *mode of production* of pulmonary edema is not definitely known. Increased fluidity of the blood on the one hand, and increased tension in the pulmonary vessels on the other, seem to be influential factors in many cases. The heightened blood-pressure may be in great part due to a failure of cardiac power, and particularly to failure of the left ventricle (Welch). When weakness of the left is out of proportion to the weakness (paralysis) of the right ventricle, the tension in the pulmonary capillaries is apt to be greatly increased, at least until transudation of serum is induced. Edema also occurs as a result of weakness of the right ventricle alone. Obstruction to the outflow, such as occurs in weakening of the left ventricle, or even obstruction in the aorta, leads to heightened tension and, secondarily, to paralysis of the right ventricle. A third factor entering into the production of pulmonary edema is the increased permeability of the vessel walls, due to impairment of the nutrition and "disturbance of the cardiopulmonic innervation" (Huchard). This usually arises in connection with toxic and infectious diseases, when the

ache, drowsiness, and vertigo. Abundant diuresis and digestive disturbances may be seen.

The *paroxysm* usually comes on in the night during sleep, and at a definite time. It may develop, however, while awake or, rarely, during the day. The onset may be sudden, but perhaps more frequently the patient first experiences a moderate grade of dyspnea and thoracic constriction. This augments with unwonted rapidity, and often attains to an inordinate degree, until the patient feels smothered, sits up, grasps his knees with his hands, or places the palms upon the bed so as to raise the shoulders and thus reinforce the accessory muscles of respiration. When the attack is severe, he rushes to an open window if able to leave his bed, or sits on a chair and places his arms on the back of another chair, so as to fix the shoulders and thus give purchase to the auxiliary muscles of respiration while frantically endeavoring to maintain the act of breathing. The *face* is pale, anxious, and soon bedewed with cold perspiration, while the lips, eyelids, and finger-tips are livid, owing to defective oxygenation of the blood. The *temperature* is subnormal and the *pulse* feeble and rapid. The clinical picture wears an alarming aspect.

Physical Signs.—*Inspection* shows enlargement of the chest, which in the advanced stage becomes barrel shaped. The reason for this is the presence of an increased amount of air in the thorax with a total inability to expel it. The respirations are diminished in frequency to 12 or 10 per minute. The natural rhythm is also greatly disturbed, and inspiration is seen to be short and gasping, and followed immediately by greatly prolonged expiration. The expansile movement of the chest is very limited, and in inverse ratio to the patient's efforts at breathing. There is lowering of the diaphragm. *Palpation* is negative in its practical results. *Percussion* yields a hyperresonance; in advanced cases with associated emphysema semitympanic resonance is common. On *auscultation* inspiration is found to be short and feeble, and expiration much prolonged and accompanied by a low-toned wheezing sound that may also be audible to onlookers. A great variety of dry râles are heard, chiefly high pitched, sibilant, and sonorous, that are more marked on expiration than inspiration. They also change their character and situation frequently. At the close of the attack moist râles may be heard, and occasionally, when bronchitis complicates asthma, the moist râles may be combined throughout the paroxysms.

The *duration* of the attack is various, ranging from a few minutes to several hours, though rarely it may endure a week or two, with spontaneous remissions during the day (*e. g.* when chronic bronchitis coexists). Usually it subsides *abruptly*, with the expectoration of rounded gelatinous masses and, later still, of mucopurulent material. The former, when floated in water, are found to be composed of the so-called *Curschmann's spirals* (mucous molds of the smaller tubes), and the spiral character of these small, ball-like pellets may even be detectable with the naked eye. When examined microscopically their spiral structure is evident. Two forms are recognized: (1) Composed of *mucin*, arranged spirally; in its meshes may be observed alveolar cells, many of which have undergone fatty degeneration. (2) A perfectly clear and translucent filament that is most probably composed of transformed mucin and occupies the center of the coiled spiral of mucin. In the early stage of the attack Curschmann's spirals (Fig. 45) are invariably present in the expectoration, and in many instances Charcot-Leyden octahedral crystals are also visible. The latter are a product of the eosinophile leukocytes and are found also in the semen, in leukemia, and in the stools of patients suffering with intestinal parasites. Müller, Fink, Leyden, and others have demonstrated extremely large numbers of *eosinophilic leukocytes* in the sputum. Fink and

Treatment.—The indications for treatment are—(1) to cut short the paroxysms and (2) to prevent a recurrence of subsequent attacks.

(1) To bring relief during the paroxysms we should ascertain the exciting cause, and remove it promptly if possible to do so. In one of my own cases a prolonged paroxysm was cut short by a calomel purge followed by an enema. An overloaded stomach calls for an emetic, and other causal factors are sometimes removable (*e. g.*, congestion of the nasal mucosa, dust, vegetable emanations). If the cause is irremovable, the patient should be kept in a freely ventilated apartment, and everything that tends to impede respiration must be removed. The choice of posture as affording the greatest relief may usually be left to the patient.

To cut short the paroxysms: Adrenalin has been shown experimentally to relieve bronchoconstriction, and clinically will very frequently abort or cut short an attack of asthma. It must be given subcutaneously (0.5 to 1.0 c.c. of 1 : 1000 solution) or may be dropped into the nose if a physician is not convenient to give the hypodermic. Adrenalin by the mouth is valueless. Massalongo places chief reliance on combined adrenalin and pituitary treatment. With this it is frequently advisable to give a hypodermic of morphin for its soothing, relaxing, and sedative effect, as one of the chief features of the cases is the dread and fear of the patient of an attack. Atropin is another drug that has a very distinct antianaphylactoid effect. It is best combined with the morphin and given hypodermically. More recently benzyl benzoate has been reported to have given excellent results in treatment of asthmatic attacks, due to its well-marked spasm-relaxing effect on smooth muscle.

(2) In order to prevent further attacks it is sometimes possible to desensitize the patient sensitive to bacterial protein by means of autogenous vaccines. Walker¹ reports that of his 28 patients who were treated with vaccines to which they were sensitive, 75 per cent. were relieved and 21 per cent. improved; of 150 non-sensitive individuals treated with vaccines prepared from sputum cultures, 40 per cent. were relieved and 20 per cent. improved. Babcock² prepares the vaccines from cultures taken from some point of focal infection; Laskowitz,³ basing his idea upon the work of Sanford in the Mayo Clinic, removes the intra-tracheal secretions by aspiration, boils it down, and from this prepares a standard solution for injection; Rogers⁴ prepares a vaccine from cultures of the sputum; Kahn and Emsheimer,⁵ on the basis that the offending protein is in the blood during an attack, withdraw 20 to 30 c.c. of blood into a sterile flask in which are a few beads, defibrinate the blood by shaking well, and then re-inject it at once into the muscles of the loin. In addition to the methods that have been devised to relieve asthmatics who are sensitive to bacterial protein, it is also possible to desensitize those sensitive to other proteins, such as animal hair, pollens, and food proteins. The sensitiveness of patients may be tested by the subcuticular injection of suspected proteins,⁶ 0.1 c.c. (the proteins from a large variety of food substances, animal emanations, and so on are on the market in order to be used for the purpose of determining sensitiveness). A positive reaction is shown by the appearance forty-eight hours after the injection of a papule surrounded by a zone of erythema, which persists for a period longer than twenty-four hours. After the determination of the offending protein, it is absolutely withdrawn from the diet and the patient is then given mi-

¹ *Arch. Int. Med.*, 1919, xxiii, 220.

² *Jour. Amer. Med. Assoc.*, 1915, lxiv, 2115.

³ *New York Med. Jour.*, 1915, xii, 950.

⁴ *Practitioner*, 1916, xcvi, 573.

⁵ *Arch. Int. Med.*, 1916, xxvii, 445.

⁶ Walker, *Arch. Int. Med.*, 1918, xxii, 466.

bleedings may precede by weeks, months, or even years any rational symptoms or physical signs of pulmonary tuberculosis. In such instances the pre-existence of latent foci of disease may be assumed.

In *quantity* the hemorrhage varies greatly, ranging from less than an ounce to a pint or more. In advanced cases in which cavities have formed large vessels may become eroded, followed by copious and dangerous hemorrhage. Fatal hemorrhage may take place into a cavity without the occurrence of hemoptysis, as in a case dissected by Osler at the Philadelphia Hospital. The distinctive characters of the blood discharged are mainly as follows: *bright color*, very *frothy* (being mixed with air), and *not clotted*. In the case of hemorrhage proceeding from a large cavity the blood may, rarely, pour forth in a free, dark stream.

Physical Signs.—These are, for the most part, negative. Quite commonly moist bronchial râles are audible on auscultation; palpation and percussion should not be practised either during or immediately after the hemoptysis.

Hemoptysis Not Due to Pulmonary Tuberculosis.—(a) In affections of the mitral and aortic valves, especially in mitral stenosis, hemorrhage from the bronchi is not uncommon, and the way in which these lesions lead to pulmonary congestion (*vide* Discussion of Organic Affections of the Heart). During the progress of these cases hemorrhages often occur at considerable intervals; they may either be slight, lasting only a few minutes, or quite free, extending over periods of a few days or a week.

(b) As a rule, in the beginning small hemorrhages occur for several weeks from pressure of an *aneurysmal dilatation* upon the bronchial mucosa, or there may be weeping of blood through the exposed layers of fibrin composing the walls of the sac. The bleeding-point can be discovered with the laryngoscope, when an aneurysm of the innominate or of the aorta impinges upon the trachea. A large and often quickly fatal hemorrhage occurs from rupture into the respiratory tract.

(c) *Arthritic hemoptysis* is undoubtedly associated with gouty, degenerative changes in the terminal blood-vessels of the lung, though no coarse pulmonary lesions are induced by the recurring hemorrhages. Although the hemorrhages may occur at intervals for years, as a rule they finally become arrested, and only rarely lead to a fatal issue. I have never observed this form of hemoptysis occurring independently of *chronic bronchitis*. In *emphysema* and *chronic bronchitis* small hemorrhages may occur, and occasionally coagula in the form of casts are formed in the bronchi and afterward ejected. It is probable that the source of the large bleedings is an *ulcer* in the bronchial mucosa.

(d) The hemoptysis that is connected with the *menstrual function* is of frequent occurrence. I saw recently a patient in whom free bleeding has occurred at intervals of four weeks for a couple of years, with an absence of the menses. In another instance, a patient of Dr. Byers, recurring hemorrhages of the lungs took place instead of the regular menstrual discharge for three successive months, and a comparatively rapid and fatal form of phthisis was developed.

(e) The preceding group is to be distinguished from those cases in which *trivial bronchial hemorrhages* sometimes occur, and in delicate, *hysterical* females. Although these bleedings are accompanied by cough, it is not uncommon to find, upon careful examination, that the blood comes from the upper air-passages.

(f) Hemoptysis may result from *severe injuries* inflicted upon the thorax and last for days.

a year or more. In a case observed by myself the patient has experienced a recurrence once annually. The paroxysms may occur at regular though much briefer intervals. The cases usually manifest ordinary bronchitic symptoms, with or without fever at the outset. The cough soon becomes troublesome and is paroxysmal. There is expectoration of rounded masses, which, when unraveled, are found to be true molds of the affected tubes exhibiting a laminated structure. The larger casts (which are of the size of a goose-quill or even larger) may be hollow. They are of whitish or grayish-white color. Hemorrhage may occur.

Physical Signs.—Owing to the obstruction offered by the casts, there is a diminished amount of air entering the corresponding part of the lung. Hence the tactile fremitus, local expansion, and respiratory murmur are diminished over the affected area. The percussion note over the uninvolved portions of the lung is clear or hyperresonant. The portions of the lung supplied by the affected tubes give impaired percussion resonance, and if they collapse, there is a dulness or percussion. Dislodgment of the casts is followed by a normal respiratory murmur.

Diagnosis.—The presence of mucous or of fibrinous casts of the finer bronchial tubules serves to distinguish this condition. The fibrinous molds met with in diphtheria and pseudomembranous croup, with extension into the bronchi, must also be eliminated. In doubtful cases a bacteriologic examination of the membranous casts should be made. If the Klebs-Löffler bacilli are then found, its diphtheritic nature is proved. In truly diphtheritic cases the membrane does not present the laminated structure.

The **prognosis** in the acute form is quite grave; the chronic variety, though pursuing an exceedingly long course that ranges from five to fifteen years, rarely terminates fatally.

Treatment.—This is to be conducted on the same principles as those in simple acute bronchitis. In the acute form an attempt should be made to soften and separate the casts by the topical application of steam, by inhalation, and alkaline sprays (*e. g.*, lime-water). Pilocarpin was employed in one instance under my own observation with apparent good results; it tends to excite free bronchial secretion. Emetics should be resorted to without delay when the signs of cyanosis show themselves.

In the chronic form nothing can be accomplished by treatment during the intervals between the acute exacerbations that will tend to obviate a recurrence of the attacks or to mitigate their severity.

to reducing the rapidity of the heart's action and lowering the blood-pressure are the ice-bag to the precordia, and aconite and other arterial sedatives internally. Lunde, Alexander, and others have found remarkable results from injection of 3 c.c. of 20 per cent. camphorated oil. Arthur Foxwell recommends venesection in cases in which *venous congestion* is present, and also lays stress upon measures that confine the blood to the systemic circulation—i. e., nutritious food, large doses of the nitrites, hot foot-baths, leeches to the anus, and ligatures applied to the thighs and arms. Brown, Otis, and others advise that the blood-pressure be frequently observed, and if found to be high, nitrite of sodium or nitroglycerin should be employed. The pulmonary capillaries may also be effectually depleted by the use of salines. I have found dry cupping over the chest of the greatest service in cases dependent upon congestion. Eating ice and partaking freely of iced drinks are also useful measures. Müller commends intravenous saline infusion to promote coagulation. Blood-serum or normal horse-serum may be used with the same object in view. A preparation of blood-platelets is upon the market as well as dried horse-serum, both of which lessen bleeding time. Hemoptysis is usually accompanied by *cough* that constantly disturbs the vascular serenity and excites fresh bleeding; it demands opium or morphin (hypodermically). Wiggers advocates pituitary therapy because this glandular substance raises systemic but lowers pulmonary blood-pressure. Amyl nitrite in doses of from 3 to 9 minims often promptly arrests the bleeding by causing an immediate fall in blood-pressure at the bleeding points, "thus giving time for clotting to take place" (Calvert). If the bronchial passages of the well lung are filling with blood, causing dyspnea and cyanosis, it is best to turn the patient on the diseased side with his head over the side of the bed (Burns). Perhaps the principal measures to control hemoptysis are the mechanical, and among these temporary artificial pneumothorax with collapse of the lung is especially advisable with hemorrhage from an ulceration.

When hemoptysis is associated with *organic disease of the heart*, the main indication is to strengthen that organ by bodily rest and quiet and by the use of cardiac tonics, especially digitalis. In a patient of my own, suffering from hemoptysis due to mitral regurgitation, the bleedings are readily controlled by the free use of digitalis.

When in *thoracic aneurysm* or *advanced pulmonary tuberculosis* the blood is ejected in mouthfuls, we may safely infer that erosion of a vessel or rupture of the aneurysm has taken place. Here the object is to bring about the formation of a thrombus that will arrest the hemorrhage. Perfect quiet in the horizontal position tends to allay the vascular excitement, and the induction of fainting by venesection is a measure worthy of a trial. Opium is contraindicated in these cases, since if cough be checked inundation of the bronchial system with the blood (the chief danger) or aspiration-pneumonia will be favored. R. H. Babcock gives an immediate injection of atropin sulphate (gr. $\frac{1}{50}$ to $\frac{1}{25}$) when hemorrhage occurs from a cavity. In repeated or severe hemorrhage from the lungs all reporters are united in expounding the splendid results obtained from inducing artificial pneumothorax.

In all instances of hemoptysis treatment should not end with cessation of the hemorrhage. A tendency to recurrence is manifested in many cases, and for small, repeated hemorrhages emetin hydrochlorid may prove of service. The patient should not be allowed to indulge in a stimulating diet; he should eschew tobacco and alcoholic stimulants, and avoid all physical and mental strain. Every source of bronchial irritation should be carefully avoided, and attacks of bronchitis, however mild, should receive the most careful attention. A climate far removed from the seaside is best. Moderate exercise is serviceable, as well as a liberal amount of nutritious food.

PASSIVE HYPEREMIA

Passive, unlike active, hyperemia is always a secondary condition, and is quite common. Two forms are distinguishable: (a) Mechanical, and (b) Hypostatic.

(a) **MECHANICAL HYPEREMIA** (*Brown Induration*).—**Pathology**.—The pulmonary vessels are distended, the lungs as a whole enlarged, and the air-cells crepitate but little, owing in great part to the encroachment upon the air-spaces by the dark venous blood. The lungs are of a reddish-brown color and afford increased resistance to efforts at cutting or tearing. On section the reddish-brown tint rapidly changes to a vivid red from oxidation of the hemoglobin when exposed to the atmosphere. The process commences at the extreme base, extends upward, and may finally become general. The interstitial connective tissue is increased, and is often edematous, while the alveolar cells contain altered blood-pigment, usually in the form of hemosiderin and responding to the usual tests for iron.

Etiology.—Mechanical hyperemia results from the obstruction of the return of blood to the left heart, and among special causative conditions are mitral constriction, mitral regurgitation, dilatation of the right ventricle, and certain cerebral injuries and diseases. It may also be a symptom of asphyxia, and rarely it arises from pressure of tumors.

Symptoms.—The most marked feature is *dyspnea*, particularly when secondary to organic cardiac diseases with failure of the right ventricle. *Cough* is common, and an expectoration of *frothy serum* or *blood* (hemoptysis) containing pigmented alveolar epithelial cells is the most characteristic clinical feature.

Diagnosis.—With a clear history, in addition to the dyspnea, cough, and the characteristic expectoration, the recognition of passive hyperemia of the lungs is a simple matter. Tillman points out that brown induration from mitral stenoses may give rise to impairment of resonance at the apex with modification of the breath sounds and the presence of moist râles in one or both apices, resembling the findings with incipient pulmonary tuberculosis. The prognosis and treatment will be considered in connection with the causative affections.

(b) **HYPOSTATIC HYPEREMIA**.—**Pathology**.—The parts of the lung that are affected are dark in color and the vesicles distended with a transudate of blood and serum. In this way the air-cells may become emptied of air (*splenization, hypostatic pneumonia*), and the resulting condition is in most instances to be regarded as a mild grade of lobular pneumonia.

Etiology.—Feeble cardiac action, as in long-continued fevers, debilitating chronic affections in old persons, combines with a prolonged dorsal position of the body (gravitation thus favoring its development) in producing the condition. This explains why the condition is found usually at the bases of the lungs, and is most marked posteriorly. It is common for the same reason in carcinoma, tuberculosis, chronic rheumatism, typhoid fever, etc. Hypostatic congestion has followed morphin-poisoning, and is particularly apt to occur in persons suffering from brain lesions, notably those which induce paralysis or coma (Hare).

The **symptoms** are wholly indefinite; indeed, none may be present. Priory has pointed out that old persons in the incipency of the disease begin to sleep with the mouth open, so as to effect the entrance of more air. Commencing cyanosis may indicate the development of hypostasis, and a careful *physical examination* of the lower lobes of the lungs will show increased fremitus, slight

blood also exhibits more or less change, as in cachectic states, general septicemia, and the like. Instances are met with in which pulmonary edema, due to vasomotor relaxation from toxic states, develops suddenly. The edema that occurs in nephritis of various types has been quite definitely shown to be due to retention of salt from inability of the kidney to excrete it. There is a consequent water retention to maintain the normal tonicity of the body fluids.

Etiology.—Pulmonary edema is secondary to pneumonia and acute and chronic affections, but not with any degree of constancy; nor is it especially liable to be associated with congestion or with low grades of inflammation of the lungs. Among the diseases of which it forms a terminal condition are—valvular affections of the heart, fatal forms of anemia, acute and chronic Bright's disease, cerebral lesions (hemorrhage, traumatism), and acute infectious fevers with failure of cardiac power. Edema may follow thoracentesis and, rarely, the intravenous injections of saline solutions.

Symptoms.—In edema of the lungs the air-space is lessened in direct proportion to the amount of serum occupying the alveoli; hence *dyspnea* is always present and is often a conspicuous symptom. There are *cough* and *bronchorrhea*. The *sputum* is usually abundant and frothy, and is expectorated with difficulty. At times, and especially in the acute forms, it is tenacious and may give rise to alarming laryngeal obstruction. It is blood-stained if congestion be combined. The condition does not give rise to elevation of temperature except in the inflammatory type, in which fever is constantly present. The pulse is accelerated and feeble, and cyanosis, particularly in cases of collateral edema, usually appears. The extremities are cool and often livid.

Physical Signs.—The reasons adduced to explain the dyspnea likewise render intelligible the physical signs encountered. There is dulness, though rarely complete, over the areas involved; the vesicular murmur is feeble or absent or there may be bronchovesicular breathing. Since the bronchioles contain serum, small bubbling râles are audible with inspiration and at the beginning of expiration over the seat of the edema.

A *recurrent variety* has been studied by Crummer, Riesman, and others, coming on without any apparent exciting cause and often proving fatal. "The chief symptoms are agonizing dyspnea, cyanosis, cough, expectoration of frothy, albuminous fluid, and profound prostration" (Riesman). Recovery from an attack is frequent and sudden.

The **diagnosis**, with a clear history, is based upon the incomplete dulness that is usually bilateral and most marked at the bases, upon the bubbling râles heard over the corresponding area, and upon the absence of any febrile movement, except the latter be due to some underlying affection. *Hydrothorax* bears some points of resemblance to edema of the lungs, but in this condition, unlike edema, the upper level of dulness is movable on change of position of the patient. Moist râles, audible in pulmonary edema, are absent in hydrothorax. *Bronchopneumonia* may be mistaken for pulmonary edema, though it has a different mode of onset. It is also accompanied by fever, glairy, tenacious expectoration, and more sharply localized areas of dulness than appear in edema.

The **prognosis** is governed by the pre-existing condition to which the edema is due. Thus, if secondary to a general dropsy due to renal or cardiac disease, it often destroys life with great rapidity. Inflammatory edema following lobar pneumonia is also grave in the extreme.

The **treatment** is that of the associated or causative affections. The limitation of the transudation and the direct removal of the serous effusion from the lungs are of great importance. We should frequently change the

be the direct cause of death. Rarely a fatal issue is due to dilatation of the right heart, followed by tricuspid regurgitation.

Treatment.—The condition is incurable. The patient should, however, be placed under the best sanitary conditions, and if practicable he should make a permanent change of climate. A suitable resort should be selected in accordance with the rules indicated in the treatment of Pulmonary Tuberculosis, and every effort should be put forth to improve the general nutrition of the patient. Due attention should be given to the associated bronchitis, as well as to any symptoms that may arise during acute exacerbations. Zimmern recommends Roentgen therapy for cicatricial retraction.

PULMONARY ATELECTASIS

(*Collapse of the Lungs; Compression of the Lungs*)

Definition.—Atelectasis of the lungs is a condition occasioned by the removal of the air from the air-cells—a state directly the opposite of emphysema. The air disappears largely in consequence of the process of absorption.

Pathology.—The affected lung spots sink in water, being non-crepitant. They present through the pleura a bluish-red tint, and on cross-section a brownish-red color. The surface of the affected areas is smooth and depressed. The bronchi supplying the collapsed parts may be occluded by inflammatory products, but, as shown by Legendre and Bailly, the air-cells involved may be inflated by means of a blowpipe.

Apart from more or less capillary distention, there are no *histologic* changes in the atelectatic areas.

Etiology.—The condition occurs most frequently in the newborn, and is then due to defective respiration. When acquired, however, there are three modes of production: (1) The first step consists in a more or less complete plugging of the smaller bronchi with mucus and other products of bronchial inflammation. If complete, air can no longer enter on inspiration, and as the contained air gradually becomes absorbed atelectasis is the natural result. This condition is very commonly associated with bronchopneumonia, especially in children. New growths may occlude the smaller bronchi and produce a similar result. (2) A frequent mode of origin is through compression of the lungs, resulting from positive intrathoracic pressure, after the normal contractility of the lung has been overcome. Instances of this may be produced by pleural effusion, hydrothorax, pneumothorax (artificially induced pneumothorax), pericardial effusion, great cardiac hypertrophy, a solid tumor, or an aneurysm of the arch. Not infrequently abdominal tumors, excessive meteorism, and ascites make sufficient upward pressure against the diaphragm to cause compression of the lower lobes of the lungs. (3) Conditions that weaken and obstruct the inspiration may produce this disease, such as certain brain affections, paralysis of the pneumogastric, and paralysis of the chest walls. Thoracic deformities may produce pulmonary atelectasis, and in extreme grades of kyphoscoliosis the lung occupying the side corresponding to the convexity of the spinal column is small. While the lung expansion and the growth of the organ are greatly interfered with, true atelectasis rarely occurs from this cause, particularly if the condition arises in youth, owing to the natural retractility of the lung. Among conditions arising from deformities of the chest is the so-called aplasia of the lungs.

Symptoms.—Atelectasis is a secondary condition, and its symptoms are very generally veiled by those of the primary disease. It arises frequently in

is attributable to congestion. Undoubtedly its exact source is the mucosa of the small bronchi; later it is the direct consequence of the ulceration of an artery or of the rupture of an aneurysmal sac that has its seat in a branch of the pulmonary artery. After the tuberculous cavities have healed, calcareous masses are, from time to time, expectorated, together with more or less blood.

(e) *Ulcers of the Larynx, Trachea, or Bronchi*.—Rarely, ulcers in adjacent structures erode the larger branches of the pulmonary artery and cause copious and speedily fatal hemorrhages. Osler observed a fatal hemorrhage in a case of chronic bronchitis with emphysema. (f) *Fibrinous bronchitis* induces hemoptysis by rupturing the capillaries in the bronchial mucosa at the time of separation of the bronchial casts. (g) *Carcinoma of the lung* produces frequent expectoration of blood. (h) *Gangrene and abscess of the lung*. (i) *Parasites (Paragonimus westermanii)*. (j) *Injuries to the thorax*.

(2) **Diseases of Other Organs than the Lung**.—(a) *Affections of the heart* act as a cause, and especially advanced mitral disease with pulmonary congestion. It not infrequently develops during the stage of adequate compensation. In a preponderating proportion of the latter instances the hemorrhage is slight, but it may be profuse and recur at intervals for many years. (b) *Aneurysm* of the branches of the pulmonary artery and of the arch of the aorta (usually with rupture of its coats) is a rare cause of hemoptysis.

(3) **Certain diseases**, such as *purpura hemorrhagica*, *scurvy*, *anemia*, *hemophilia*, and *malignant forms of certain acute infectious diseases* (e. g., *yellow fever*), cause hemoptysis. In this class of cases the hemorrhages are due either to a diseased condition of the vessel walls or to the tendency to spontaneous hemorrhage that occurs in the blood dyscrasia.

(4) **Vicarious hemoptysis** is not uncommon during menstruation or when amenorrhea is present. Unless occurring at the time of the regular menses it is not to be regarded lightly, and is of the same significance as when taking place in the male.

(5) **Endarteritis**.—According to Sir Andrew Clarke this is a common cause of recurring hemorrhages in aged persons.

Symptoms.—Hemoptysis is so commonly a symptom of that most frequent and dread disease, phthisis, as to raise suspicions of the latter in the minds of the laity and physicians as soon as it occurs. It is appropriate, therefore, to note, first, the features of hemoptysis when dependent upon pulmonary tuberculosis, and then to point out its clinical peculiarities when due to other conditions.

In **incipient pulmonary tuberculosis** hemoptysis develops suddenly as a rule, a *warm, saline taste*, lasting but a few moments, generally preceding the expectoration of blood. The blood is *coughed* up, and the bleeding may last only a few minutes or may continue for days, the sputum being apt to remain blood-stained for a longer period. The immediate effect of the hemorrhage, however slight, is to alarm the patient, inducing, besides mental agitation, cardiac palpitation and other nervous concomitants. A small hemorrhage is not attended with any other results, but large ones give rise to the symptoms of *shock*, combined with those of *symptomatic anemia*. When the hemorrhage is large, blood to the amount of a mouthful may be ejected with each cough, and in these instances the effect of the profuse bleeding is evidenced by such symptoms as vertigo, syncope, cold extremities, excessive pallor, perspiration, and a rapid, small, feeble pulse. This is followed, if the attack does not prove speedily fatal, by considerable restlessness, and later not infrequently by mild delirium and more or less fever.

In comparatively rare instances the same patient has a single hemorrhage; more frequently he has several at shorter or longer intervals. Large or small

bleedings may precede by weeks, months, or even years any rational symptoms or physical signs of pulmonary tuberculosis. In such instances the pre-existence of latent foci of disease may be assumed.

In *quantity* the hemorrhage varies greatly, ranging from less than an ounce to a pint or more. In advanced cases in which cavities have formed large vessels may become eroded, followed by copious and dangerous hemorrhage. Fatal hemorrhage may take place into a cavity without the occurrence of hemoptysis, as in a case dissected by Osler at the Philadelphia Hospital. The distinctive characters of the blood discharged are mainly as follows: *bright color*, very *frothy* (being mixed with air), and *not clotted*. In the case of hemorrhage proceeding from a large cavity the blood may, rarely, pour forth in a free, dark stream.

Physical Signs.—These are, for the most part, negative. Quite commonly moist bronchial râles are audible on auscultation; palpation and percussion should not be practised either during or immediately after the hemoptysis.

Hemoptysis Not Due to Pulmonary Tuberculosis.—(a) In *affections* of the *mitral* and *aortic valves*, especially in mitral stenosis, hemorrhage from the bronchi is not uncommon, and the way in which these lesions lead to pulmonary congestion (*vide* Discussion of Organic Affections of the Heart). During the progress of these cases hemorrhages often occur at considerable intervals; they may either be slight, lasting only a few minutes, or quite free, extending over periods of a few days or a week.

(b) As a rule, in the beginning small hemorrhages occur for several weeks from pressure of an *aneurysmal dilatation* upon the bronchial mucosa, or there may be weeping of blood through the exposed layers of fibrin composing the walls of the sac. The bleeding-point can be discovered with the laryngoscope, when an aneurysm of the innominate or of the aorta impinges upon the trachea. A large and often quickly fatal hemorrhage occurs from rupture into the respiratory tract.

(c) *Arthritic hemoptysis* is undoubtedly associated with gouty, degenerative changes in the terminal blood-vessels of the lung, though no coarse pulmonary lesions are induced by the recurring hemorrhages. Although the hemorrhages may occur at intervals for years, as a rule they finally become arrested, and only rarely lead to a fatal issue. I have never observed this form of hemoptysis occurring independently of *chronic bronchitis*. In *emphysema* and *chronic bronchitis* small hemorrhages may occur, and occasionally coagula in the form of casts are formed in the bronchi and afterward ejected. It is probable that the source of the large bleedings is an *ulcer* in the bronchial mucosa.

(d) The hemoptysis that is connected with the *menstrual function* is of frequent occurrence. I saw recently a patient in whom free bleeding has occurred at intervals of four weeks for a couple of years, with an absence of the menses. In another instance, a patient of Dr. Byers, recurring hemorrhages of the lungs took place instead of the regular menstrual discharge for three successive months, and a comparatively rapid and fatal form of phthisis was developed.

(e) The preceding group is to be distinguished from those cases in which *trivial bronchial hemorrhages* sometimes occur, and in delicate, hysteric females. Although these bleedings are accompanied by cough, it is not uncommon to find, upon careful examination, that the blood comes from the upper air-passages.

(f) Hemoptysis may result from *severe injuries* inflicted upon the thorax, and last for days.

(g) *Parasitic hemoptysis* due to *Paragonimus westermanii*. The sputum resembles that of lobar pneumonia with intermittent hemoptysis.

(h) A person may have a single or many recurring attacks of hemoptysis *without assignable cause*, if we except severe muscular strain or intense mental excitement. Although pulmonary tuberculosis does not supervene in instances of this sort, yet not a few may be excited by a permanently limited tuberculous focus which may be indeterminable by the usual methods of examination. I have more than once seen a cure result from an active course of treatment with appropriate hygienic measures. In well-marked instances of this kind a complete arrest of the trouble resulted from a change of climate.

Differential Diagnosis.—A reliable diagnosis necessitates the exclusion of hemorrhage from the higher air-passages, pharynx, esophagus, and stomach. In *epistaxis* the blood may directly enter the nasopharynx, excite cough, and be discharged as in hemoptysis. An examination of the nasal chambers should be made when epistaxis is suspected. Bleeding may take place from the gums, from chinks in the pharynx, or from varicose veins. If the seat of the bleeding be the *pharynx*, the hemorrhage is not free, the blood being commingled with a preponderating proportion of mucus; if from the gums, it may be more copious (as in ptyalism or scurvy). An inspection of the mouth will decide the question. Strümpell distinguishes hysteric hemoptysis by the smaller bleedings, the absence of pus elements, and the large amount of squamous epithelium, leptothrix, and the food-remnants present.

Hemoptysis must be distinguished from *hematemesis* (*q. v.*).

Prognosis.—The gravest apprehensions are constantly entertained by sufferers from hemoptysis, but immediately fatal results are of rare occurrence; and of this fact the patient should be repeatedly assured by his physician. In case, however, of thoracic aneurysm the consequences of hemoptysis are fatal. With reference to the effect of hemoptysis upon tuberculous pulmonary disease, opinions differ widely. Prior to the existence of cavities it often exerts a favorable influence upon the disease. On the other hand, if cavities exist, an opposite effect is observed. Some blood finds its way into the bronchi below the point of bleeding and into the air-cells, causing at times irritation and even lobular inflammation. Thus hemorrhages may aid in rendering the tissues susceptible to tuberculous infection. In cases of profuse hemorrhage, due to the erosion of large branches of the pulmonary artery in phthisical cavities, death may be suddenly induced, and is caused largely by inundation of the lung and the consequent impossibility of respiration. Fatal hemorrhages are less common in the female than in the male sex.

Treatment.—Since the hemorrhage is ascribable to (1) congestion of the bronchial mucosa, (2) erosion of the vascular walls, and (3) blood-changes, obviously the treatment of individual cases must be modified according to the character of the causative condition.

In many instances of *hemoptysis due to congestion of the bronchial mucosa* the hemorrhages are, comparatively speaking, slight; hence, apart from keeping the patient at absolute rest for from twenty-four to forty-eight hours after the cessation of the bleeding, little treatment is required. If free, the physician's aim should be to decrease the force of the heart's contraction, and to accomplish this end the patient should be placed in bed, and not allowed to change his position nor to speak above a whisper. The patient should lie on the diseased side (if this be known). The affected side of the chest may be strapped with adhesive plaster. Neumann observed that the tendency to bleeding stopped at once, in some cases, after the patients were allowed to get up out of bed. The diet should be light, nutritious, and non-stimulating, all hot drinks and alcoholics being prohibited. Among cardiac sedatives employed with a view

PULMONARY EMBOLISM

(Hemorrhagic Infarction; Embolism of the Lungs)

Pathology.—Embolic infarctions are firm, airless, brown or black, wedge-shaped masses, with their bases usually at the pleura, which soon becomes lustreless and covered with fibrin. The infarctions may be single or multiple, and may occupy the greater portion of the lobe; in most cases, however, their size equals that of a walnut. Their most frequent seat is at the back of the lower lobe. The microscope shows the presence of leukocytes and red blood-corpuscles in the air-cells and in the alveolar septa. Collateral congestion and edema are frequent concomitants, and, rarely, pneumonic consolidation.

Etiology.—The condition is produced by the blocking of the pulmonary arteries by an embolus or thrombus. When the circulation in the pulmonary capillaries is feeble, hemorrhagic infarction may be the result of stasis, and this is probably the most frequent form. It is met in diseases of the lungs and also in mitral affections. The plug that occludes the blood-vessel may be composed of leukocytes, as in leukemia, and the chief sources of the emboli are the thrombi in the right heart, in consequence of dilatation, and in the systemic veins. Infectious emboli, resulting in abscesses, occur (*vide* Abscess of the Lungs). An embolism of placental cells in cases of eclampsia has been described. It is met with during the puerperium as well as following operations, particularly on the abdomen (366 in 439 cases on record—Petren). Occlusion of a branch of the pulmonary artery cuts off completely the circulation to the territory supplied by that branch, and hemorrhagic infarction occurs—venous extravasation, with expression of air.

Symptoms.—Not all infarctions give rise to symptoms; on the contrary, occlusion of a main branch of the pulmonary artery usually terminates life speedily. The latter accident occurs not infrequently in connection with organic disease of the heart, and if death be not the immediate result or if a narrower branch be occluded, alarming symptoms ensue, such as *syncope*, *hypnea*, *pain in the side*, and *convulsions* with *unconsciousness*. The first and most distressing symptom is dyspnea, attended by frantic efforts at breathing and by great mental anxiety. Occasionally *hemoptysis* is an early symptom, and of primary significance if it occur in a patient suffering from mitral disease. Cough usually supervenes, accompanied by the expectoration of dark, gelatinous, mucoid masses. Large lymph-cells containing blood-corpuscles are found in the sputum, most commonly in instances of organic cardiac affections.

The physical signs may either be negative—as, for example, when the infarctions are small or deeply located—or they may give information as to the seat and extent of the affected part. When present they are those of sharply localized consolidation (increased fremitus, percussion-dulness, moist rales, bronchial or bronchovesicular breathing). It is not improbable that in many cases the physical signs are due, in great part, to associated conditions, such as bronchitis, edema, or collateral consolidation. The appearance of the friction-sound in the course of suspected cases is a great aid in diagnosis. The heart's action becomes enfeebled, the pulse is small and frequent, and the surface of the body is cool and frequently bedewed with cold sweat. Fever may either be present at the onset or absent throughout. The signs of embolic abscesses in the lungs will be elsewhere detailed (*vide* Pulmonary Abscess).

Diagnosis.—To establish the diagnosis of pulmonary embolism there must be a clear history of some etiologic condition, and the sudden appearance of such symptoms as dyspnea, cough, bloody expectoration (in particular),

(d) It most frequently, however, follows *bronchopneumonia* of either acute or subacute form (Charcot). The process starts in the bronchi and extends to the surrounding lung tissue, until finally an entire lobe, or even an entire lung, may become involved. Tuberculous bronchopneumonia also leads to the production of new fibrous tissue, but here the process is a conservative one (*vide* Pulmonary Tuberculosis), and hence is not to be classed with chronic interstitial pneumonia.

(e) The initial lesions may be located in the adherent pleura, with secondary involvement of the lung, connective-tissue bands extending into its substance. The bronchi are inflamed and sometimes dilated.

Chronic interstitial pneumonia may, however, exist without implication of the pleura, and in view of this fact the primacy of pleural thickenings cannot be granted without reserve when they form a part of the lesions of fibroid induration.

The various forms of the disease thus far described arise *secondarily*. It may also occasionally originate as a *primary* affection (1) from the inhalation of different forms of dust (*vide* Pneumonokoniosis). (2) Delafield describes "a special form of lobar pneumonia." He contends that lobar pneumonia terminates only in resolution or in death, and that this special disease, with its production of newly-formed connective tissue, is a distinct form of inflammation. The variety described by Delafield runs a subacute or even chronic course, and terminates by crisis. It is an exudative inflammation, with the formation of new tissue from the onset. The consolidated areas are not so large as in ordinary pneumonia, and sections lack the granular character of the latter.

Symptoms.—The patient suffers from *cough*, which increases in intensity with the progress of the affection. There is a mucous, seromucous, or (rarely) bloody expectoration; *dyspnea* occurs early, and frequently is present only on ascending heights; uneasiness, or even *pain*, over the side of the chest involved may be experienced. In cases in which the bronchi become dilated the characteristic symptoms of bronchiectasis are superinduced. The *general symptoms* consist merely in a loss of flesh and of strength. *Fever* is altogether absent.

Physical Signs.—*Inspection.*—The chest wall of the affected side is retracted, while the healthy lung is enlarged (*compensatory emphysema*). The spinal column is curved laterally. The affected side is fixed during respiration, and the heart is displaced by traction toward the affected side. If the left lung be involved, the apex-beat will be displaced to the left and slightly upward; if the right, the apex-beat will be observed to the right of its normal position. The ribs approximate, thus obliterating the interspaces, and the shoulder droops over the shrunken chest wall.

Palpation.—The tactile fremitus is usually increased; if the pleura be much implicated or thickened, however, fremitus may be decreased. *Palpation* discovers no expansile motion.

Percussion.—The percussion-note varies. Dulness is common, owing to consolidation of the lung, but flatness is sometimes met with, and a tympanic or amphoric note is occasionally elicited over a dilated bronchus.

Auscultation.—The breathing is bronchial or more or less sonorous as a rule, and over bronchiectatic cavities it is cavernous or, rarely, amphoric. Near the base it is frequently feeble, distant, or even altogether suppressed. Subcrepitant, sonorous, sibilant, or gurgling râles may be audible, and dry, creaking, or leathery friction-sounds may also be heard.

Prognosis.—The course of the complaint is exceedingly chronic, lasting over many years. Death may result from an intercurrent attack of acute pneumonia affecting the other lung. The disease always shortens life, and may

the course of bronchopneumonia, but passes unnoticed unless it becomes very extensive. *Respiration* is carried on by the upper and anterior portions of the lungs, is increased in frequency, and is laborious. The *pulse* is small, rapid, and feeble; the *skin surface*, especially that of the extremities, is cool.

The form presenting the most typical symptoms is that occurring in the newborn. It is evidenced by *shallow, rapid breathing, lividity, cold extremities, a faint whining cry, drowsiness*, and sometimes by evidences of *motor irritation*, such as muscular twitching and convulsions. Congenital anomalies of the circulatory organs are associated.

Physical Signs.—When it involves a goodly portion of the lower lobes posteriorly, as frequently happens, there is marked retraction during inspiration over the lower portion of the thorax, due partly to external atmospheric pressure and partly to the contractile efforts of the diaphragm. Dulness on percussion is only revealed when the atelectasis is extensive, and the tactile fremitus, though very various, is generally decreased or even absent. Localized compensatory emphysema may present semitympanitic resonance over small areas of collapse.

Auscultation shows a greatly diminished or absent vesicular murmur, and, if the area of collapse be large, bronchial breathing. Among associated sounds is the subcrepitant râle due to bronchopneumonia, and, indeed, capillary bronchitis and atelectasis are often combined, there being, moreover, no reliable signs that will separate them clinically.

The *aplasia* of the lung that is produced by spinal curvature (*kyphoscoliosis*) richly deserves brief separate description, owing to its clinical importance. In many instances the chest is more or less twisted on its own axis, shortened in the vertical diameter, and thoroughly fixed. Under these circumstances lung expansion is impossible, and hence respiration is purely diaphragmatic. In many other patients life may be prolonged for an indefinite period, nothing more being observed than slightly labored breathing. Such persons, however, upon great physical exertion suffer urgent dyspnea, and the development of an ordinary bronchitis may lead to similar results, and even to speedy death.

The **physical signs** are those of localized emphysema, combined with those of more or less compression of the lungs. There is an extension of the cardiac dulness to the right, and other evidence of right ventricular enlargement, to which may succeed dilatation with its usual clinical events. Death is not rarely due to this failure of compensation.

Autopsies have shown the lungs to be small and more or less compressed, some portions being almost airless. Areas of emphysema are often associated. The right ventricle may be hypertrophied merely, or dilatation may also have taken place. Congenital atelectasis, by keeping up high pulmonary pressure, may lead to persistence of the ductus Botalli and of the foramen ovale.

Diagnosis.—Atelectasis may be distinguished from *lobar pneumonia* by the absence of an initial rigor, fever, crepitant râles, and the pain of the latter disease, and by the characteristic inspiratory retraction of the lower portions of the chest and the smaller areas of dulness.

Pleuritic effusion gives a flat percussion-note, the upper level of which varies with a change in the position of the patient—a sign that is wanting in atelectasis.

Prognosis.—When the condition is limited to small areas it is rarely serious, but equally seldom does extensive atelectasis lead to recovery. The outlook depends to some extent upon the nature of the associated affections; thus, when secondary to whooping-cough and wide-spread bronchopneumonia it is very fatal. Other diseases that may complicate and increase the gravity of the atelectasis are pleurisy and pulmonary tuberculosis. On the other hand, compensating emphysema often coexists, and is to be regarded as salutary in

COMPENSATING EMPHYSEMA

This variety is limited to certain parts of the lung, and arises in consequence of pathologic changes in other parts of the same organ that prevent full expansion of the lung on inspiration. Hence a vicarious increase in the volume of the air-cells is observed in circumscribed morbid processes such as occur in pulmonary tuberculosis, lobular pneumonia, cirrhosis, and pleurisy with adhesions (particularly when the latter is situated at the inferior border of the lung). An entire lung, unaffected by the primary disease, may be the seat of compensating emphysema when the causal disease invades the whole or a greater portion of the other lung, as in cirrhosis, extensive pleurisy with effusion, lobar pneumonia, and pyopneumothorax. When, however, the latter conditions are confined to a portion of one lung, the remainder of the same organ becomes distended also. The term *acute emphysema* is applicable to many of the cases. Kelman, in her studies on acute emphysema as found so frequently on postmortem examination of those dead from influenza in the recent pandemic, holds that the following factors are responsible for the condition: 1, Weakening of the lung parenchyma by the virus; 2, toxic action of the virus on the respiratory center, resulting in dyspnea and cyanosis, "in itself sufficient to produce emphysema"; 3, the resulting emphysema thus produced increasing the dyspnea and cyanosis; 4, the combination of all these factors acting on already weakened alveoli to produce acute vesicular emphysema.

As a rule, this pulmonary change is physiologic and beneficial; only rarely secondary atrophy of the walls of the air-cells develops.

Symptoms are not presented by the lungs in consequence of the changes met with in compensating emphysema. The condition is sometimes recognizable by means of the usual physical signs, but even these are not always to be relied upon. Fortunately, its existence may be safely inferred when there is conclusive evidence of the presence of the local causative diseases (bronchopneumonia, pulmonary tuberculosis, pleurisy, lobar pneumonia).

HYPERTROPHIC EMPHYSEMA

Nature of Emphysema.—The symptoms are dependent upon a loss of elasticity in the lungs, and, the latter condition being the result of overstretching, the contractile energy of the lungs is in great part destroyed; hence they become permanently enlarged. We may in some cases account for the loss of elasticity in the lungs by the operation of causes that produce an abnormal degree of stretching, either temporarily or constantly; but under these circumstances emphysema would be developed despite the pre-existence of normal contractility of the lung. In true emphysema, however, which develops at a comparatively early period in life, we may safely assume that the retractile energy is defective (probably a congenital condition), and hence in such cases the action of the usual causal factors will speedily engender overdistention, or emphysema may develop even in the absence of causative influences. In these instances there is probably a quantitative as well as a qualitative defect in the elastic-tissue element of the lungs.

Pathology.—The thorax is enlarged (barrel shaped), and upon removing the sternum the lungs are found completely to fill the mediastinum, and do not retract as in health. They present a pale, anemic appearance, although pigmented patches and streaks may be noted. To the touch they appear soft and feathery, though dry. They readily pit on pressure (a leading characteristic).

Immediately beneath the pleura enlarged air-cells can be distinguished macroscopically. At the anterior borders a series of air-blebs, resembling a

frog's lung, may be observed. The pleura is pale, and in patches the pigment may be absent (*Virchow's albinism*).

Upon microscopic examination it is observed that the dilatation starts in the infundibular and alveolar passages. The septa are partially obliterated, the alveolar walls thinned, and, lastly, perforated, while in consequence of these changes the air-cells communicate with one another, forming larger or smaller air-sacs. The process is an atrophic one, the smaller elastic fibers disappearing, while the larger become less prominent and often ruptured. After the latter changes have begun the capillaries likewise disappear, and the epithelium of the air-cells undergoes fatty degeneration, though in the larger bullæ a pavement layer is retained. The smooth muscular element may also occasionally be found hypertrophied (*Rindfleisch*). The clinical phenomena probably arise from the loss of the capillary blood-vessel system and collateral hyperemia of the larger bronchial vessels.

The bronchial mucous membrane is usually the seat of chronic inflammation. The smaller tubes may be dilated (*bronchiectasis*), and hyperplasia of the peribronchial connective tissue may be associated. The diaphragm is lowered and the subjacent viscera correspondingly depressed.

Physiologic Pathology.—The heart is pushed downward and somewhat backward. The right side shows well-marked changes; the cavities are dilated and hypertrophied, due to obstruction in the pulmonary circulation; and in long-standing cases hypertrophy of the left chambers may also develop. The pulmonary artery and its branches are enlarged and the seat of atheromatous degeneration. The liver, kidneys, and other viscera present the changes that belong to chronic venous engorgement.

Etiology.—The affection is often secondary to, and develops in consequence of, other affections of the lung—notably *whooping-cough* and *chronic bronchitis*, particularly the dry form. The disease is attributable to the mechanical influences to which the alveolar walls are subjected during respiration. This abnormal strain attends inspiration to some extent, but mainly expiration, owing to the obstruction to the egress of the air in the smaller bronchi, with increased *intra-alveolar air-pressure*. The increased tension in the air-cells may be accounted for partly by the severe and persistent cough, the air being thus driven into the apices of the lungs, forcibly expanding them and causing emphysema. Syphilis and alcoholism are among the recognized causes.

Bronchial asthma, on account of the obstruction of the exit of the air from the lungs, produces during the attacks an acute emphysema that may result finally in a condition of permanent overdilatation. Certain occupations such as blowing wind-instruments, or those that entail severe muscular strain (e. g. blacksmithing), act as predisposing causes. Edsall's studies, however, show that glass-blowers and players on wind instruments are not especially liable. The disease is often *hereditary*. During *advanced years* the lung elasticity often diminishes, and as a consequence a disposition to emphysema is engendered. On the other hand, emphysema is not infrequently met with in children, and in such there may be a temporary respite, with a recurrence at a later period. An emphysematous tendency also results from congestion of the lungs associated with mitral valvular disease.

Clinical History.—In nearly all cases the disease develops insidiously, the symptoms being gradually added to those of the primary affections (*chronic bronchitis, asthma, etc.*). When due to occupation its development is also slow, and not infrequently its origin dates back to childhood or beyond the recollection of the patient. Rarely it may exhibit a more acute development, e. g., after whooping-cough.

The first symptom is a variable degree of *dyspnea*, and to this may be added temporary *cyanosis* and *cough*. The severity of the dyspnea varies

with the degree of distention of the air-cells, even though additionally aggravated by the coexistence of the primary disease. The labored breathing is shown particularly in expiration, and, as in asthma, in which the alveolar spaces are acutely distended, so in emphysema the rhythm of the respiration is changed. The inspiration is shortened, and the expiration is greatly prolonged and accompanied by wheezing when chronic bronchitis coexists.

In the later stages cyanosis becomes more marked, and is noticeable in proportion to the loss of compensation and interference with the cardio-pulmonary circulation. It often attains to an extreme degree, and the patient's alarming appearance may be in striking contrast with his apparent degree of comfort. In mild forms the cyanotic tint is confined to the lips, lobes of the ears, and the extremities. Any increase in the degree of dyspnea after exertion results in an increased blueness of the surface.

The cough is dependent upon the presence of chronic bronchitis, which frequently coexists, particularly during the winter. The expectoration is identical with that of chronic bronchitis, and when this disease reaches an advanced stage the cough persists throughout the year (*vide* Chronic Bronchitis). Since chronic bronchitis in its highest grades is met with at an advanced period of life, so, as would be expected, the cases of advanced emphysema are also met with at the same period. Osler has described a group of cases occurring in patients "from twenty-five to forty years of age who, winter after winter, have had attacks of intense cyanosis in consequence of an aggravated bronchial catarrh." These patients are short-breathed from infancy, and their condition is attributed to a primary defect of structure in the lung tissue.

General Symptoms.—There is no fever, the temperature being generally subnormal, and the pulse, though sometimes feeble, is not increased in frequency. There is a very gradual loss of flesh and strength, and the patient is stoop-shouldered, presenting a peculiar cachectic appearance—in strong contrast with the dusky appearance of the face, the swollen neck, and the enlarged chest.

Finally, other symptoms may be mentioned that are for the most part secondary to hypertrophy, followed by dilatation, of the right ventricle. This hypertrophy is the result of pulmonary congestion and obliteration of the pulmonary capillaries induced by the emphysema. Under these circumstances severe attacks of cough occur, attended with extreme dyspnea and lividity, and later the conditions that usually succeed a moderate grade of tricuspid insufficiency supervene, such as congestion of various viscera and edema of the feet. Anasarca is rare.

Physical Signs.—The shape of the chest is characteristic: owing to the increased anteroposterior diameter, it becomes barrel shaped (Fig. 46), and the sternum bulges, as do also the costal cartilages. The infraclavicular and

Fig. 46.—Barrel-shaped chest in emphysema.

is of slow development, and the rational symptoms of pneumothorax are more constant and urgently distressing than those of emphysema. Pneumothorax is unilateral, and gives a purely tympanitic percussion-note, while hypertrophic emphysema is bilateral and its percussion-note is hyperresonant. Amphoric breathing, metallic tinkling, the characteristic succussion splash, and an absence of the vesicular murmur, usually present in pneumothorax, are absent in emphysema.

Another affection giving rise to dyspnea, cough, and cyanosis is *pleurisy with effusion*, but the slow course, the absence of fever, and the universal hyperresonance that characterize emphysema do not belong to pleurisy. The latter affection yields a flat percussion-note.

Prognosis.—Hypertrophic emphysema of acute form (*e. g.*, resulting from whooping-cough) is often curable; but the usual slowly generated variety gives an unfavorable prognosis as to recovery. In many cases, however, life is not materially shortened. Temporary improvement is possible when the lesion consists merely of a distention of the air-cells, and is shown by a corresponding improvement in the physical signs. If the vital capacity, as shown by the spirometer, is reduced one-half or more, the prospect is unfavorable. Recurring attacks of bronchitis intensify the symptoms of a disease that is innately progressive. Intercurrent affections, such as pneumonia (lobar and lobular) and pulmonary tuberculosis, may prove fatal. Dropsy, following broken compensation, is a dangerous complication; other late accidents are hemoptysis and sudden dilatation of the right heart.

Individual circumstances, such as the patient's social condition, the stage of the affection in which he comes under proper treatment, and the degree of care he is willing to exercise, greatly influence the outcome of the case.

The **treatment** is to be directed toward the removal of the causes of emphysema, and chiefly of the chronic bronchitis. From personal observation I am firmly convinced that the progress of the disease can be arrested and that the condition is sometimes improved by relieving the chronic bronchitis. The iodids (potassium, sodium, and ammonium) at times produce effects that are truly remarkable. If not well borne by the stomach, the syrup of hydriodic acid may be employed. If the occupation of the patient tends to aggravate the disease, it must be forsaken for a less harmful one. Violent paroxysms of cough and intercurrent attacks of asthma contribute to the production of alveolar distention, and hence must be alleviated promptly by appropriate therapeutic measures. Attacks of acute bronchitis are to be prevented by suitable clothing, by avoidance of exposure to inclement weather, dust, and the vitiated atmosphere of overcrowded halls, churches, and the like; whenever practicable the result can be most successfully obtained by a residence in an equable climate. Since a severe bronchitis is apt to increase the severity of the emphysematous symptoms, it must be relieved as speedily as possible. Passive congestion, flatulence, and constipation, with other gastro-intestinal symptoms, demand careful regulation of the diet and especially a restriction in the use of carbohydrates. The bowels must also be moved regularly with the same end in view.

The heart needs to be carefully watched, and as soon as signs of broken compensation appear digitalis will be found highly useful. Diuretics and cathartics may also become necessary. The sudden development of urgent dyspnea and extreme lividity, especially if associated with weak cardiac action and a rapid, feeble, irregular pulse, calls for free bleedings. In my hospital practice I have seen the lives of patients suffering from emphysema saved by timely venesection.

To assist the patient in expiration Gerhardt has suggested systematic *mechanical compression* of the thorax during expiration. Pressure is made by

an attendant, who places his hands flat on the lower lateral portions of the thorax, and the manipulation is to be continued for from ten to fifteen minutes daily. The results obtained by certain German authors have been encouraging, but in my own hands the method has failed except in two instances occurring in young adults with yielding chest walls, in whom it was of the greatest service. The aim should be to strengthen the muscles of the diaphragm by prolonged expiration, supplemented by drawing in the abdominal walls as the act of expiration draws to a close—not before. The *pneumatic treatment*, comprising the inhalation of compressed air and the breathing into rarefied air, richly deserves further trial,¹ its use having been productive of permanent improvement in a number of cases, as shown by physical examination (including mensuration). Oxygen by inhalation has proved serviceable. Freund has employed operation—removal of small portions of the upper costal cartilage—in order to do away with the primary costal rigidity and the dilated thorax.

SENILE EMPHYSEMA

This variety is a senile atrophy of the lungs, and has been appropriately termed “small-lunged emphysema” by Sir Wm. Jenner. In consequence of the complete atrophy of the alveolar walls, coalition of the air-cells takes place, with the production of large air-sacs. The lungs contain less than the normal volume of air, instead of an abnormal quantity as in hypertrophic emphysema, hence occupy less space in the chest cavity than do healthy lungs. The pulmonary tissue is deeply pigmented. The condition does not produce right ventricular hypertrophy.

The symptoms are negative, although subjects in whom senile emphysema develops may have previously had chronic bronchitis with more or less dyspnea. They quite frequently present a withered appearance, and the chest on inspection is seen to be contracted, owing to the fact that the ribs approximate more closely and take a more oblique direction than in health.

Treatment is unavailing.

GANGRENE OF THE LUNGS

Pathology.—The affection presents itself in two forms: (a) a diffuse, and (b) a circumscribed process.

(a) The diffuse variety is rare. It may, however, be met with in lobar pneumonia, and very rarely in consequence of occlusion of the large branch of the pulmonary artery; it may also be secondary to the circumscribed form. The greater part of the lobe, or even an entire lung may be involved, the pulmonary parenchyma degenerating into a putrid, greenish-black, pulpy mass, with no obvious line of demarcation.

(b) The circumscribed form may involve either one or both lungs, though the right is affected somewhat oftener than the left. To this category belongs the so-called *embolic gangrene*, the nodules of which have their favorite seat in close proximity to the pulmonary pleura. All etiologic varieties of the circumscribed form more frequently implicate the lower than the upper lobe of the lung, occurring in sharply defined areas, which may either be single or multiple. The affected area first presents a greenish-brown appearance; its central portion soon undergoes softening, and a cavity is thus formed whose walls are ragged and irregular and contain a foul-smelling, dark, greenish liquid. The surrounding lung is inflamed and there is an intense bronchitis. Emboli may then be detached from the focus of infection and, entering the circulation, may set up foci of septic inflammation in remote organs. A truly remarkable

¹ Waldenberg's portable apparatus is not convenient for use.

nection exists between circumscribed gangrene of the lung and cerebral abscess. When the gangrenous spot is situated near the pleura, simple or gangrenous pleurisy may arise as a complication, or the pulmonary pleura may be perforated and pyopneumothorax result. When recovery ensues the cavities formed as the result of the conversion of lung tissue present a limiting wall of dense connective tissue. Such cavities may remain permanently or may slowly become contracted.

Etiology.—Gangrene of the lungs is caused by the bacteria of putrefaction. Buday found many organisms, but most frequently a combination of uniform bacilli and spirilla, which he holds to be the specific etiologic factor. The disease is rare. It is only when the lung tissue has become impaired or peculiarly altered that the specific bacteria are capable of producing gangrene. It may occur in several ways:

(1) Secondary or lobar pneumonia, hemorrhagic infarctions, cavities in the lungs, bronchiectasis, wounds of the lung, contusions of the thorax, carcinoma of the esophagus, or to compression or embolism of the pulmonary artery or of the bronchial vessels.

(2) By lodgment of an embolus, derived from a gangrenous area in distant parts; this form is common, especially in children. The embolus is often the result of otitis media, mastoiditis, or thrombosis of the lateral sinus. There is postoperative gangrene of the lungs.

(3) Pressure from a thoracic aneurysm may give rise to gangrene.

(4) The most important causal factor, however, is the entrance of foreign bodies, especially bits of food, into the bronchi and lungs. Whether or not the specific bacteria of putrefaction enter the lungs with the foreign bodies, the latter render the tissue-soil receptive to the former, and once the process has been initiated it is apt to extend itself. There are several ways in which these foreign particles gain entrance into the bronchi and lungs: (a) By a faulty swallowing of the food; (b) by inhalation; (c) by a carcinomatous perforation of the esophagus into the bronchus or into the lung.

(5) In debilitated states of the system, as during convalescence from protracted fever (rarely) and in diabetes mellitus (frequently).

Symptoms.—These are *local* and *general*.

Local Symptoms.—There is severe *cough*, which is accompanied by an exceedingly *fetid expectoration* that is usually quite profuse. When abundant, and when expectorated into a conical glass and allowed to stand for a time, it separates into three layers: (a) the uppermost being frothy, opaque, and of a grayish-yellow color; (b) the middle, clear and watery, and (c) the lowest appearing as a greenish-brown sedimentary layer containing shreds of lung tissue and sometimes blood. The microscope shows it to consist of numerous elastic fibers, bacteria, fat-crystals, mucopus, granular matter, and leptothrices. Small quantities of blood in the sputum are very common. The patient's breath is, as a rule, intensely fetid, but this fetor of breath may be absent, as in a case of my own (which came to autopsy), in which the localized gangrenous process had no fistulous connection with the bronchus. If any of the large branches of the pulmonary artery be eroded, free and even fatal hemoptysis will result. *Pain* in the chest is complained of when the lesions are superficially situated.

The *physical signs* are sometimes obscure, as when the areas involved are smaller and deeply situated, and in such instances signs of bronchitis only may be detectable. When large and favorably situated, however, the affected spots usually give signs of consolidation, rapidly followed by those of cavity. In addition, bronchial râles—usually moist—and coarse cavernous râles are usually audible. It is obvious that when the pleura is implicated the signs

of pleurisy are added, and if pneumothorax be present those belonging to the latter condition also.

The chief **general symptoms** are irregular fever, emaciation, and profound prostration. Leukocytosis is found. A septic condition is commonly developed, and the patient sinks from exhaustion. The serious general features may overshadow the local in the lungs. Rarely there may be an almost total absence of constitutional disturbances, and such instances terminate in recovery.

Diagnosis.—The distinctive feature is fetidity, both of the sputum and the breath. The physical signs may readily determine the existence of the pulmonary lesion, but it is difficult to eliminate *abscess* and *fetid bronchitis* associated with bronchiectasis. The results of a careful examination of the sputum, together with the less horribly fetid odor of the breath, in *abscess* will usually suffice to eliminate the latter affection. In *fetid bronchitis* the fetor of the breath and sputum is less marked, while its course is slower and more favorable than in gangrene.

The **prognosis** is always grave, though rarely recovery in circumscribed gangrene of the lungs ensues. The chief dangers are exhaustion and hemorrhage. Improved methods of surgical treatment, however, have saved life in a few instances, and promise to reduce still further the mortality rate of this serious affection.

Treatment.—The patient's nutrition must be maintained, if possible, by a concentrated liquid diet, administered in fixed quantities and at regular intervals; also by the judicious cultivation of the digestive functions, together with the use of stimulants and tonics. Morphin is indispensable for the cough, which would otherwise rapidly induce exhaustion. For a description of the surgical treatment of gangrenous cavities of the lungs the reader is referred to special works on surgery. It is the physician's duty, however, to determine whether or not the patient's general condition will admit of surgical intervention, and also to localize as nearly as may be the affected zones for the surgeon's guidance. In doing this he will be greatly aided by stereographic roentgenograms.

ABSCESS OF THE LUNGS

(*Suppurative Pneumonitis*)

Pathology.—This affection is characterized by the formation of pus and the degeneration of lung tissue. It may be (a) a mere infiltration of the blood-vessels, bronchi, or interstitial tissue, but more frequently is seen as (b) an ordinary abscess. In size the abscesses range from that of a walnut to an apple, and I have observed in one case inflammation of the whole of the middle lobe of the right lung. The abscess walls are irregular and decidedly ragged; and in the case of old lesions there is a dense fibrous wall; the contents are purulent and rarely necrotic. The most common seat ("80 per cent.") is in the lower lobes. If the contour of an abscess touches the pleura, empyema is the result. Rupture of the abscess into the pleura may also occur.

Etiology.—Streptococci are found, though they are not the only direct causes of abscess of the lung. The pneumococcus and Friedländer's bacillus have been found, as well as certain other organisms. *Predisposition* is noted in certain conditions, as (1) during or following the occurrence of inflammation, as in lobar and lobular pneumonia. Suppurative infiltration, however, more frequently arises under these circumstances than abscess, and in the rare instances in which the latter occurs it is apt to be comparatively small and

Multiple. In all forms of inhalation and deglutition bronchopneumonia, however, abscess of the lung is a frequent sequel. In a study of 100 cases these two factors, aspiration of infected material into the lung or a primary lung inflammation, *e. g.*, pneumonia, were responsible for 94 per cent. of the cases of lung suppuration, according to Wessler.¹

(2) Perforation of the lung from without or from adjacent organs, *e. g.*, esophageal carcinoma, hepatic abscess, or suppurating hydatid cyst.

(3) Infectious emboli, found in connection with septicopyemia, frequently cause metastatic abscesses in the lungs. In a mechanical manner they may produce hemorrhagic infarctions, followed by suppuration, or the latter process may occur independently of the former. The abscesses are usually situated close to the pleura, and are frequently wedge shaped; they vary in number from one to several hundred, and in size from a pin's head to an orange.

(4) Inward extension of a purulent pleurisy.

(5) As elsewhere stated (*vide* Pulmonary Tuberculosis), suppuration is quite generally associated with chronic pulmonary tuberculosis.

(6) Other rare causes for the lung suppuration or diseases which predispose to it include diabetes, syphilis, actinomycosis, and secondary to esophageal carcinoma (Wessler).

Symptoms and Diagnosis.—The examination of the *sputum* is of the greatest value in the diagnosis of this disease, since, being purulent, it usually presents a yellow, or less frequently a greenish- or brownish-yellow color. It emits a feter that is less pronounced than that of either gangrene or trid bronchitis. Particles of lung tissue may be visible in the pus, and on microscopic examination of the latter, elastic fibers, the presence of which is of the utmost importance in the diagnosis, may be found in profusion. The physical signs of infiltration and of cavity are of the greatest assistance in distinguishing abscess of the lung; these, however, are wanting unless the abscess is of a considerable size. The signs of cavitation, together with the characteristic sputum, leave no room for doubt. Chills and suppurative fever usually attend. Leukocytosis is present. The history is of considerable importance, confirming the more characteristic features. Thus antecedent pneumonia or septicopyemia would be strongly corroborative. The roentgenogram should always be employed in doubtful cases as an additional aid in diagnosis. *Tuberculosis* distinguishes itself by the history, the diminished amount of pus expectorated, and the sputum test.

The **prognosis** is often hopeless, as, for example, when the disease is associated with pyemic processes in other parts of the body. On the other hand, those rare instances in which it is secondary to pneumonia give a comparatively favorable outlook.

Treatment.—The chief aim in the therapeutics should be to support the patient by the administration of tonics, stimulants, and antiseptics, as well as energetic feeding with light forms of nourishment. When the abscess is situated near the periphery of the lung surgical interference is to be advised as soon as the first indications of increasing weakness appear. Pulmonary abscess occurring as a sequel of pneumonia with free expectoration should receive an expectant treatment unless it tends to become progressive, when it is for operative intervention. For the details of the operation for pulmonary abscess the reader is referred to works on surgery. In uncomplicated cases, that is, without extensive adhesions occurring in young individuals, lobectomy has been frequently successful. The statistics of Eisendrath relating to abscess following pneumonia may, however, be mentioned, as follows: of 25 cases of the simple abscess, 24 recovered and 1 was improved; in chronic abscess the results were much less favorable.

¹ *Jour. Amer. Med. Assoc.*, 1919, lxxiii, 1918.

the pulmonary connective tissue by the inhalation of stone-dust by those who follow such occupations as stone-cutting, knife- and axe-grinding, and millstone making. The irritating properties of this form of dust are proved by the great disposition in this subvariety of pneumokoniosis to the formation of fibrous nodules and diffuse areas of sclerosis in the lungs. The nodules have a gray center and a darker periphery; they are exceedingly dense, and sections are made with much difficulty.

(3) **Siderosis.**—This term implies a collection of iron oxid in the lungs, also due to the pursuit of certain occupations (dyeing, iron-smithing, etc.). Cases of much the same nature are caused by the inhalation of vegetable dusts by grain-shovelers, cotton-spinners, cigar-makers, etc. The *pathologic changes* are identical with those in anthracosis, though the color appearance is red instead of black.

Symptoms.—Rarely the *onset* is marked by the symptoms of acute, followed by those of chronic, bronchitis; but in a vast majority of instances chronic bronchitis gradually develops after long exposure to the action of the exciting cause. The symptoms of emphysema are soon superadded, the patient now suffering from dyspnea, and less frequently from asthma. The *sputum* is diagnostic in anthracosis, being quite dark; in chalicosis a microscopic examination is essential to show the particles of silica; while in siderosis the expectoration presents a reddish color. Apart from the foreign particles, the sputum is for a long period of years mucopurulent in character, and later it often contains the tubercle bacillus.

The *physical signs* are not distinctive, being identical with those met with in chronic bronchitis associated with emphysema, and followed by those of interstitial pneumonia, and sometimes by those of cavity.

The **diagnosis** is to be made both from the history, from a gross or microscopic examination of the sputum, and, most accurately, from a study of the roentgenogram, which is an invaluable aid in the diagnosis, as has been shown by the careful studies of Pancoast at the University of Pennsylvania. It may be confirmed by the invariable presence of the signs of bronchitis and emphysema, as well as by the effect of removal to an atmosphere free from dust. In the later stages the detection of infallible evidences of phthisis only serves to corroborate the earlier diagnosis of pneumokoniosis.

An *acute pneumokoniosis*, due to the inhalation of Thomas phosphate meal, has been described. This dust causes a diffuse pneumonic inflammation affecting principally the lower lobes. The symptoms and progress of the cases are like those of lobar pneumonia.

The **prognosis** is favorable in hygienic surroundings until the more advanced stage is reached.

Treatment.—A change of occupation or several hours of exercise in the open air daily for those who are exposed to dust in work-rooms should be advocated. Dusty work-rooms must be properly ventilated.

The active treatment is the same as for chronic bronchitis and emphysema from other causes, and is to be appropriately modified when pulmonary tuberculosis develops.

NEW GROWTHS OF THE LUNGS

CARCINOMA OF THE LUNG

All varieties of carcinoma have been met with in the lung, but, with rare exceptions, carcinoma of this organ is of secondary origin. Ordinarily the primary new growth involves a vein or lymph-channel, and the latter carries the germ of the disease to the lung. It is also to be recollected that it may result

atous tumor communicates with a wide-mouthed bronchus, bronchial breathing may be audible, and the physical signs of lung cavity may be developed. The signs of general bronchitis are present in most instances, especially in the disseminated form of the disease; in the latter the lung may shrink, with retraction of the chest walls on the affected side. If secondary pleurisy with effusion occurs, the detection of the characteristic cancer-cells in the contents of the pleural cavity will show the nature of the thoracic affection.

Diagnosis.—The following symptom-group will pretty well establish a diagnosis: A peculiarly shaped dull area (as when it extends under the sternum), perhaps a marked prominence over the site of the tumor, enlarged and hard lymphatic glands in the vicinity, and certain of the compression symptoms—circulatory, nervous, bronchial, or tracheal. Rarely the diagnosis may be made by the occurrence of metastasis to the chest wall. Metastasis occurred in about 54 per cent. of 61 primary cases (Lavrionovich). Again, the discovery of cancer tissue in masses accidentally detached gives reliable indication of the disease. An exact diagnosis can often be made from an examination of the particles on aspiration of the tumor and pleural effusion. McMahon and Carman¹ maintain that the Roentgen examination and stereoscopic study of roentgenograms will early point to a pulmonary lesion, which is quite typical.

The differential diagnosis between pulmonary carcinoma and *pulmonary tuberculosis*, with which it is commonly confused, can be made with positiveness only by a careful microscopic examination of the sputum. From *fibroid induration* of the lung it is easily discriminated, owing to the history and slower course of the latter affection.

Prognosis.—This is bad, as death may occur suddenly from abundant hemorrhage or more frequently from either exhaustion or asphyxia. The duration of the affection varies from six months to a year or more.

The treatment must be addressed chiefly to the relief of pain and other subjective symptoms, though the effect of the roentgen ray should be tried.

SARCOMA OF THE LUNG

Primary sarcoma of the lung is rare, but in instances of generalized sarcomatosis the lungs show larger or smaller nodules "in almost every case" (Birch-Hirschfeld), occurring in connection with osteosarcoma of other organs or in lymphosarcoma of the cervical glands.

Secondary sarcoma of the root of the lung by sarcomatous disease of the postbronchial glands, is more common than secondary carcinoma. The diagnosis is reached as in carcinoma (*vide infra*).

Neoplasms occurring among the cobalt-miners of Schneeberg were described by Hesse and Tragner as lymphosarcomata—slowly growing masses that attained to a large size and gave metastasis to lymph-glands, pleura, liver, and spleen. In most cases there was an associated pneumokoniosis, which had probably predisposed to the new growth.

HYDATID CYST OF THE LUNG

Hydatids in the lungs may either be primary or secondary, the former variety being exceedingly rare and the latter somewhat less so. Almost invariably the echinococci are developed in other organs—the liver in particular—and find their way to the lungs either by direct perforation through the diaphragm or by entering through the blood-current. The lungs are involved in about 12 per cent. of hydatid disease.

For etiology and pathology see Hydatid Cysts of the Liver.

¹ *Amer. Jour. Med. Sci.*, 1918, cliv, 34.

that the effusion, if serous, is rarely sufficiently dense to cause any diminution of the sounds; in fact, they are usually louder than on the affected side. This is best obtained near the upper level of the fluid in large effusions, and at or above the angle of the scapula when the effusion is moderate.

(2) *Stage of Resorption*.—With resorption of the fluid there is a decrease in the size of the affected side, together with a return of the normal appearance of the intercostal spaces and the respiratory movements. In many instances there is positive retraction, leading to thoracic deformity with displacement of neighboring organs toward the affected side; and this retraction may be either general or circumscribed. The inferior intercostal spaces are more or less narrowed; the shoulder droops; the nipple approaches the median line; the spine may be curved, the convexity being directed toward the sound side (quite rarely toward the affected side); and the scapula projects from the chest-wall on the affected side. In children, and even in adults, the lungs and thorax gradually expand in order to overcome this chronic deformity.

Palpation.—The tactile fremitus closely follows the fluid as it subsides from above downward without any extreme degree of thickening of the pleural membranes, though cohesion of their surfaces may prevent its return over the lower segment. The inspiratory movement of the chest wall gradually returns, but not to its former limit.

Mensuration shows a steady diminution in the size of the side involved, which finally becomes smaller than its fellow.

Percussion.—The dull or flat note gives way to normal percussion resonance, proceeding from above downward in a gradual manner; but the latter is not renewed over the lower portion of the pleural cavity for a long period after the exudation has disappeared. The abnormal areas of flatness due to displacement of organs (liver, spleen, heart) also disappear.

Auscultation discloses most important signs during the stage of absorption. The breath-sounds reappear at first above, and then lower down, until the base is reached. With commencing subsidence of the fluid the respiratory sounds are feeble and distant, but later they resume their natural distinctness; and partly as a result of the revival of the natural muscular tonicity, and partly in consequence of the disappearance of the fluid, the two roughened pleural surfaces come in contact and play upon one another, giving rise to a rubbing, creaking friction-sound on auscultation. These friction-murmurs may persist for months after the effusion has been absorbed. Occasionally the lower portion of the compressed lung remains permanently inexpandible; the upper portion of the lung is now the seat of compensatory emphysema. The heart sounds return to their normal position.

Roentgen Rays.—Williams states when the effusion is large no more rays pass through it than through the liver, and the outlines of the diaphragm, ribs, and heart are obliterated on the side of the effusion. The fluoroscope also shows the direction and extent of cardiac displacements due to pleural effusions. Williams affirms that displacement of the heart to the right may not be recognized by percussion, even when it has been pushed much beyond its normal place. Displacement of the pleuritic fluid when the patient's position is changed and also with the movements of the diaphragm is noted with the fluoroscope.

Special Clinical Forms of Acute Sero-fibrinous Pleurisy.—

(1) *Tuberculous Pleurisy*.—This is, in the majority of instances, secondary to pulmonary tuberculosis. On the other hand, the primary lesions may be situated in the pleural sac and give rise to (a) *Acute serofibrinous pleurisy* (with the usual course); (b) *Subacute pleurisy* (with insidious course), leading to tuberculous invasion of the lungs, and (c) *Chronic adhesive pleurisy*, in which

lastic pleurisy; (b) serofibrinous pleurisy; (c) purulent pleurisy (empyema), and (d) chronic adhesive pleurisy.

Bacteriology.—In all forms of the disease the *direct* causes are various micro-organisms or their irritating chemical products. Conspicuous among these is the *Bacillus tuberculosis*. Inoculation of guinea-pigs with the latter by Eichhorst gave positive results in 15 out of 23 cases, and by La Damany in 47 out of 55 cases. By taking a large amount of exudate either for cultures or inoculation of animals the *Bacillus tuberculosis* can be found, as a rule. Netter, Prudden, and others have found in the exudation of **fibrinoserous pleurisy** the *Streptococcus pyogenes*, *staphylococci*, the *typhoid bacillus*, and the *diplococcus of pneumonia*. The micro-organisms most commonly present in **empyema** are the *Micrococcus lanceolatus* and the *streptococcus*, the former especially in the pleurisy associated with pneumonia (in two-thirds of the cases occurring in children—Levy), and the latter in those independent of pneumonia, particularly in adults. Among other pathogenic organisms that have been found rarely in the effusion are the *colon bacillus*, the *Proteus vulgaris*, the *gonococcus*, the *Entamæba coli*, *Friedländer's bacillus*, *anthrax bacillus*, *influenza bacillus*, and various saprophytic bacteria. Except in the case of the pleuritic exudation in pneumonia, in which the diplococcus alone is present in about one-half of the cases, the aforementioned micro-organisms are generally found in association.

ACUTE PLASTIC PLEURISY

(Dry, Fibrinous Pleurisy)

Pathology.—The lesions are usually circumscribed, the part inflamed being intensely injected. It has lost its natural lustre, and instead has a dull, non-glistening surface "like a tarnished mirror," due to a slight fibrinous exudate. Minute ecchymoses are seen. Later the exudate may become more copious, when the pleura presents a rough, shaggy appearance. On account of the friction between the two pleural membranes in high grades of dry plastic pleurisy the exudate may be very thick, and its color appearance is then yellowish or reddish gray. This sheeting of fibrinous exudate entangles in its meshes numerous embryonic round cells, out of which blood-vessels and connective tissue are developed. The opposing surfaces of the pleura adhere. Occasionally, in the lighter grades, the disease does not advance to firm adhesion, and in such instances the products of the exudate undergo fatty degeneration and are absorbed.

Etiology.—The affection may be (a) primary or (b) secondary. (a) By the *primary form* is meant an inflammation of the pleura occurring in previously healthy persons. It is exceedingly rare, and doubtless many instances of true secondary pleurisy are regarded as belonging to this category. Aschoff's studies of 200 cases of pleurisy showed 41 to be idiopathic. Of great etiologic prominence is exposure to cold and wet, and next to this stands mechanical injury. It is more common in men than in women, and especially during the time of active life, on account of the greater liability to exposure of the former sex. The changeable weather of the winter and spring augments the proportion of cases during these seasons as compared with summer and autumn.

(b) The *secondary form* of dry plastic pleurisy arises from extension of acute and chronic inflammatory affections of the lungs and other neighboring organs. Hence it frequently accompanies lobar pneumonia, somewhat less frequently bronchopneumonia, and more rarely still hemorrhagic infarct, abscesses, and pulmonary carcinoma and gangrene. When pleurisy occurs on the right side it must be recollected that it may have originated in hepatitis.

give a history very similar to that of acute pleurisy, but the characteristic physical signs of pleurisy are absent.

Prognosis.—The duration of the affection varies from a few days to three weeks, and the immediate outcome is favorable as a rule. Undoubtedly, however, a primary attack predisposes to subsequent attacks, and thus, as a result of repeated seizures, pleural thickening and intrapleural adhesions often arise. Lung expansion may in this manner be restricted, with the gradual development of interstitial pneumonia as a consequence. Acute plastic pleurisy is not infrequently a terminal condition in serious forms of illness (*e. g.*, septicopyemia and chronic nephritis).

Treatment.—The first object in the treatment is to relieve the pain, and this can best be accomplished by the hypodermic use of morphin. The inflammatory process is best controlled by absolute *rest* in the recumbent posture, or fixation of the affected side by means of adhesive plaster. I am also in the habit of administering moderate-sized doses of quinin (gr. iv—0.25—three times daily) and salicylates. After the exudation has appeared, the iodids of iron and potassium, in combination, may be employed. *Locally*, nothing is so effective as cold in the form of the ice-water bag or Leiter's coil, preceded, in robust patients, by the local abstraction of blood (ʒiij to vj—90.0–180.0) by leeches. At the end of one week the morphin may usually be discontinued. During *convalescence* the patient should be instructed to take deep inspirations several times in succession, not less than a dozen times each day, with a view to obviating as far as possible pleural adhesions and other unfavorable consequences. Symptomatic anemia may be present at this time, and should be met by iron given internally. At this time iodine may be used locally with great benefit; I have not, however, seen any favorable results from blisters. For the pain which continues in the side after all detectable physical signs have disappeared the use of the constant current over the seat of the pleurisy for twenty minutes at a time gives almost instantaneous relief (Loomis).

SEROFIBRINOUS PLEURISY (PLEURISY WITH EFFUSION, SUBACUTE PLEURISY)

Pathology.—During the first stage of serofibrinous pleurisy the changes are the same in character as those met with in dry pleurisy, though of severer grade, and usually involving the greater portion of the pleura on the side affected. There is an abundant exudation of serum, and usually the entire pleura becomes coated with a fibrinous exudate that varies greatly in thickness and arrangement. The exudate is thin and smooth in some instances, though more frequently it forms a thick layer, presenting a shaggy surface on the one hand or an irregular, honeycombed surface on the other. Lymph in the form of flocculi is rather abundant in the serous effusion. The interlobular pleural surfaces are also invaded as a rule, in consequence of which they become adherent. The fluid exudate varies greatly in quantity ($\frac{1}{2}$ to 8 pints—4 liters), is often of a citron color, and is, in the majority of instances, clear or slightly turbid. Rarely it is of a dark brown color.

Unless adhesions between the pleural surfaces have previously existed the effusion gravitates to the most dependent portion of the pleural cavity. Microscopically, there are found leukocytes, red blood-corpuscles, endothelial cells, threads of fibrin, and, rarely, crystals of cholesterin and uric acid. The composition of the fluid is almost identical with that of blood-serum, and on boiling it is found to be rich in albumin. Spontaneous coagulation may take place on standing.

Changes in the Neighboring Organs.—So long as the normal retractility of the lung is not overcome by the fluid that collects in the pleural cavity, the latter does not produce positive intrathoracic pressure, and hence does not

produce displacement of adjacent organs. It may be assumed that until the pleural sac is at least one-half filled with serofibrinous exudate the natural contractility of the lung is not destroyed. At this period there may be a slight displacement of the mediastinum toward the opposite side, due to traction exerted by the normal retractility of the sound lung. Obviously, large effusions must in a mechanical manner displace the pleural membranes, thus causing compression of the pulmonary structures lying above the effusion. A very copious effusion may push the lung up and back against the vertebral column and convert it into a small, flat, bloodless, and airless mass (atelectasis). While a total absence of air in the collapsed lung is due chiefly to compression by the fluid, to some extent, however, the air may be absorbed by the vessel or even by the effusion (Strümpell).

Together with compression of the lung by the effusion, pressure is also exerted by the latter against the mediastinum, causing displacement of the heart. The mediastinum also loses the normal traction force of the lung upon the affected side, and hence the lung on the sound side draws the mediastinum toward itself by its own retractile energy. Osler shows that even in the most extensive left-sided effusion the heart's apex is not rotated, but that the normal relative position of the apex and base obtain, though the apex is in some instances lifted, and in others the heart lies more transversely. The right chambers of the heart occupy most of the anterior part of the organ, showing that the displacement of the mediastinum with the pericardium and its contents to the right involves no appreciable twisting of the heart itself.

Downward displacement of the diaphragm takes place in extensive effusion on the right side, depressing the liver to a variable distance below the interior costal border; on the left side large effusions produce pressure displacement of the stomach and the transverse colon, and, to a slighter extent, of the spleen. Pre-existing adhesions may prevent displacement of the adjacent organs.

Etiology.—The causative factors are identical in nature with those producing dry plastic pleurisy. It is highly probable that the degree of severity is dependent upon the previous condition of the patient, whether he be suffering from some other affection or not, and upon the amount of specific poison gaining access to the pleura.

The affection may be *primary*, but is much more often *secondary*, and this fact may be explained by reference to any of the specific micro-organisms producing the affection.

Direct Causes.—Many of the cases follow quickly upon exposure to cold or wet or an injury to the thorax. I thoroughly agree with those authors who contend that about three-fourths of the cases of serofibrinous pleurisy are of tuberculous origin. The tuberculous process may invade the pleura primarily, but more often it is secondary to tuberculosis of the lungs; less frequently, though oftener than is generally supposed, it is secondary to tuberculous peritonitis. In these instances the tubercle bacilli probably find their way from the peritoneum to the pleura by traversing the lymphatics in the diaphragm. A large percentage of apparently primary cases of tuberculous pleurisy have their origin in a circumscribed and more or less latent tuberculous focus in the lungs. It is not improbable also that tuberculous processes in other viscera may furnish the tubercle bacilli for secondary pleural infection. Moreover, the fact that many cases of serofibrinous pleurisy recover does not disprove their tuberculous nature.

The affection is not infrequently secondary to acute articular rheumatism, which is itself a microbic affection. It also arises as a complicating condition in the course of various acute and chronic affections of the chest, as pericarditis and catarrhal pneumonia, and may develop in acute infectious diseases, as typhoid fever or lobar pneumonia. On the other hand, the bacillus of Eberth

as been known to provoke pleurisy (Bozzolo, Fernet, and others¹). It may occur as a complication in the chronic affections of various viscera (chronic nephritis, cirrhosis, and carcinoma of the liver). The *predisposing causes* are the same as for the dry plastic form.

Symptoms.—The description here refers particularly to primary serofibrinous pleurisy, and it is important to recollect that when secondary to other acute and chronic affections characterized by great bodily weakness the pleuritic symptoms may be in abeyance.

With few exceptions the onset is *insidious*, the symptoms being quite mild; but rarely there is a *sudden onset* with active symptoms (rigor, high fever). In the majority of instances the patient first complains of a *stitch-like pain* in the side; this is rarely pronounced, but is aggravated upon deep breathing and upon any muscular exertion. *Dyspnea* soon arises and gradually increases in intensity. *Cough* may be present or absent, and in some instances is attended by a scanty mucoid expectoration that may rarely be blood-streaked.

The *constitutional symptoms* are of correspondingly slow and gradual development. From the commencement of the attack a moderate febrile movement at night may be observed, and the pulse will be found to be frequent, small, and compressible, or, more rarely, tense. At the time of the patient's first visit to his physician he may give a history of having gradually lost flesh and strength for a period of weeks together, though he may not have been obliged to abandon his vocation. He looks pale, his countenance wears an anxious expression, and he is without appetite. These cases frequently drag on from two to four weeks before consulting a physician, the local symptoms going unnoticed.

Sometimes the period of invasion develops acutely and after lasting a few days the symptoms exhibit a decided remission; subsequently there may be a sudden recurrence of the local and general phenomena, and particularly of the dyspnea. The pleural cavity, which may have been one-half or two-thirds full, now becomes completely filled.

Special Symptoms.—*Pain.*—Chest pain is an almost constant but not highly characteristic symptom, and, though usually among the earliest symptoms, it may not be present until a few hours or a day after the commencement of the affection. It may be described as a sharp, shooting pain, and is popularly termed a "stitch in the side." It may, however, be tearing or dragging in character. Its intensity is not a safe indication of the severity of the disease. It is usually referred to a small spot below the nipple or to the midaxillary region; exceptionally, however, it is more diffuse, and in my experience it has not infrequently been retrosternal or referred to limited areas below the inferior costal border. When absent it may be excited by coughing, sneezing, deep inspiration, and stooping. With the appearance of the effusion the pain diminishes and, as a rule, soon disappears.

Dyspnea.—The breathing is shallow, "catching," inspiration being made up of a series of gasps, and it is hurried in consequence of the severe pleural pain; in copious effusions, that render one lung functionless, the dyspnea may become intense, even attaining to orthopnea. It reaches its most pronounced form in previously robust subjects, and in those in whom the effusion has developed rapidly. On the other hand, when the pleural sac fills slowly dyspnea may be absent except on exertion. Following marked disturbances in the respiration *cyanosis* appears and may become quite marked.

Cough and Expectoration.—Little need be added to what has already been stated. When much expectoration is present it is not uncommonly due to associated bronchitis or to pulmonary tuberculosis; there may, however,

¹ *Annual of the Universal Medical Sciences*, vol. ii, p. 12.

and, owing to the differences in the vocal vibrations in the two sexes. In pleurisy effusions tactile fremitus may usually be obtained. The apical impulse can also be readily located by palpation. The displaced spleen or liver can be felt through the abdominal wall, and must not be mistaken for an actual enlargement of these organs.

Mensuration.—In right-handed adults the right side is, normally, slightly larger than the left; and it is only after the effusion is considerable that the sphygmometer shows any alteration in the thoracic contour. The tape, however, exhibits the difference in expansive motion of the two sides early. At the end of expiration the circumference of the affected side will be found to be one or two inches greater than that of the unaffected side, while at the end of inspiration the difference will be but slight. The cyrtometric tracing also shows a discrepancy between the horizontal outlines of the two sides.

Percussion.—At first the percussion-note is impaired either posteriorly or in the infra-axillary region, and a little later there is dulness, tending toward flatness (deadness), the upper level of which rises from day to day with increasing effusion. Over the exudate the note has a wooden quality (flat) and there is great resistance. When the effusion rises to the fourth rib anteriorly there is dulness over the fluid above and absolute flatness below. When the exudate rises to the lower border of the third rib the percussion-note above the line of dulness is tympanitic or vesiculotympanitic (*Skoda's resonance*); this holds also in more moderate effusions, and is attributable to mediate relaxation of the lung. In copious exudations the cracked-pot sound may be elicited immediately below the clavicle, and *Williams' tracheal tone* may sometimes be obtained. This may also be obtained at a point corresponding to the seat of the compressed lung. When the patient is sitting or in the erect posture the upper limit of dulness in large effusions is not a horizontal line, but is highest at the spine and falls as we proceed to the front, which is its lowest point. The upper line of dulness in moderate effusions begins "relatively low down in the back, passes upward from the vertebral column, and soon turns upward and proceeds obliquely across the back to the axillary region, where it reaches its highest point; thence it advances in a straight line, but with a slight descent, to the sternum" (Ellis). This curved line resembles the italic letter *S* (Garland). Grocco's sign (a triangular area of dulness over the back on the opposite side in unilateral pleurisy, which dulness disappears when the patient lies on the side of the effusion) is confirmatory, although it is not invariably present. On the right side the flatness is continuous with that of the displaced liver; on the left it passes into and may obliterate Traube's semilunar space.

Auscultation.—The signs of the first stage have already been described (vide Plastic Pleurisy). With the appearance of the effusion the breath-sounds become weak, distant, and have a bronchial quality. This bronchial breathing is more marked with large effusions where the lung is completely collapsed. As a result of this consolidation of lung tissue the bronchial breathing is so intense that it may simulate a pneumonia. The latter sounds may exhibit a metallic or amphoric quality, and may be accompanied by râles (pseudocavernous signs). The latter are more frequently met in children than in adults, and often give rise to a false diagnosis. Above the level of the fluid there is bronchovesicular breathing, and on the opposite side intensified breath-sounds may usually be noted. In pneumonia with pleural effusion there may be loud and persistent bronchial respiration over the exudate. The vocal resonance may manifest a nasal quality, simulating somewhat the bleating of a goat (*Laennec's egophony*). The vocal fremitus is theoretically diminished, but on account of the lung collapse a condition of solid lung tissue results which transmits the voice sounds so directly from the large bronchi

that the effusion, if serous, is rarely sufficiently dense to cause any diminution of the sounds; in fact, they are usually louder than on the affected side. This is best obtained near the upper level of the fluid in large effusions, and at or above the angle of the scapula when the effusion is moderate.

(2) *Stage of Resorption*.—With resorption of the fluid there is a decrease in the size of the affected side, together with a return of the normal appearance of the intercostal spaces and the respiratory movements. In many instances there is positive retraction, leading to thoracic deformity with displacement of neighboring organs toward the affected side; and this retraction may be either general or circumscribed. The inferior intercostal spaces are more or less narrowed; the shoulder droops; the nipple approaches the median line; the spine may be curved, the convexity being directed toward the sound side (quite rarely toward the affected side); and the scapula projects from the chest-wall on the affected side. In children, and even in adults, the lungs and thorax gradually expand in order to overcome this chronic deformity.

Palpation.—The tactile fremitus closely follows the fluid as it subsides from above downward without any extreme degree of thickening of the pleural membranes, though cohesion of their surfaces may prevent its return over the lower segment. The inspiratory movement of the chest wall gradually returns, but not to its former limit.

Mensuration shows a steady diminution in the size of the side involved, which finally becomes smaller than its fellow.

Percussion.—The dull or flat note gives way to normal percussion resonance, proceeding from above downward in a gradual manner; but the latter is not renewed over the lower portion of the pleural cavity for a long period after the exudation has disappeared. The abnormal areas of flatness due to displacement of organs (liver, spleen, heart) also disappear.

Auscultation discloses most important signs during the stage of absorption. The breath-sounds reappear at first above, and then lower down, until the base is reached. With commencing subsidence of the fluid the respiratory sounds are feeble and distant, but later they resume their natural distinctness; and partly as a result of the revival of the natural muscular tonicity, and partly in consequence of the disappearance of the fluid, the two roughened pleural surfaces come in contact and play upon one another, giving rise to a rubbing, creaking friction-sound on auscultation. These friction-murmurs may persist for months after the effusion has been absorbed. Occasionally the lower portion of the compressed lung remains permanently inexpandible; the upper portion of the lung is now the seat of compensatory emphysema. The heart sounds return to their normal position.

Roentgen Rays.—Williams states when the effusion is large no more rays pass through it than through the liver, and the outlines of the diaphragm, ribs, and heart are obliterated on the side of the effusion. The fluoroscope also shows the direction and extent of cardiac displacements due to pleural effusions. Williams affirms that displacement of the heart to the right may not be recognized by percussion, even when it has been pushed much beyond its normal place. Displacement of the pleuritic fluid when the patient's position is changed and also with the movements of the diaphragm is noted with the fluoroscope.

Special Clinical Forms of Acute Sero-fibrinous Pleurisy.—

(1) *Tuberculous Pleurisy*.—This is, in the majority of instances, secondary to pulmonary tuberculosis. On the other hand, the primary lesions may be situated in the pleural sac and give rise to (a) *Acute serofibrinous pleurisy* (with the usual course); (b) *Subacute pleurisy* (with insidious course), leading to tuberculous invasion of the lungs, and (c) *Chronic adhesive pleurisy*, in which

the course and physical signs correspond with those to be depicted in a special section on Chronic Pleurisy.

The morbid lesions are similar to those met with in other forms plus the specific tubercles, which may be exceedingly numerous (miliary tubercles) on the one hand, or confined to a few circumscribed areas on the other. This variety has no special etiologic connection with empyema, and the effusion is usually serofibrinous and often blood-stained.

It should be pointed out that tuberculous pleurisy is sometimes followed by tuberculous pericarditis or peritonitis, or both. The two latter affections have been considered elsewhere (*vide* p. 272). We must grant that tuberculous pleurisy may proceed favorably with apparent recovery, though too often, after a variable interval of time, tuberculous symptoms are manifested. R. C. Cabot obtained the subsequent histories in 221 cases of pleural effusion in the Massachusetts Hospital; he followed them five years until phthisis or death took place in 117; at the end of five years 96 had recovered. It is found that about 30 per cent. merge into pulmonary tuberculosis.

(2) **Diaphragmatic Pleurisy.**—This term is applied to those instances in which the diaphragmatic portion of the pleura is involved either alone or in part. There occurs an exudate that may be either plastic or serofibrinous, though rarely large in amount. The *symptoms* are acute, and the pain, which is lancinating in character and situated in the epigastric region, is the most prominent feature. Geuneau de Mussy holds that pain along the tenth rib, extending from the anterior extremity to the sternum and xiphoid cartilage, is pathognomonic. It is increased by deep inspiration and by pressure over the insertion of the diaphragm at the tenth rib, and often abates when effusion takes place. Dyspnea is a marked symptom in most cases, and the patient may be forced to assume a stooping or sitting posture, the respirations being superficial, purely thoracic, and "catching." Cough, nausea, and even vomiting may occur. In a case under my own care vomiting, due most probably to associated peritonitis, was a troublesome symptom.

The *constitutional features* are quite pronounced, particularly the fever, which exceeds that met with in other forms of pleurisy. The patient's anxiety is extreme. The effusion may be purulent, and if so, bulging of the lower intercostal spaces, followed by edema, may occur.

The physical signs are for the most part negative.

(3) **Encysted Pleurisy.**—This term has reference to effusions that are circumscribed in consequence of adhesions between the pleural membranes. There may be two or more pouches, with or without communication. This so-called encapsulated pleurisy may occupy any part of the chest, and is exceedingly variable in extent. The symptoms and physical signs are rarely trustworthy for diagnosis, but should usually afford ground for suspicion, and lead to an exploratory puncture.

(4) **Interlobar Pleurisy.**—This variety is usually secondary to, or associated with, the ordinary type of acute serofibrinous pleurisy. The serous surfaces between the lobes are involved in the inflammatory process, and the fluid becomes encapsulated in this position in consequence of interlobar pleural adhesions. It is more frequent on the right than on the left side, and its favorite seat is near the root of the lung, between the upper and middle lobes. Osler met with a case following pneumonia in which there was between the lower and upper and middle lobes of the right side an enormous purulent collection that looked at first like a large abscess of the lung. Fistulous connection with a bronchus often occurs, and the purulent expectoration that follows may be the first symptom to attract attention to the process of suppuration in the thorax. Prior to the occurrence of this accident the patient

Diagnosis.—In diagnosing pleurisy our attention must be directed chiefly to the physical signs. Unfortunately, the rational symptoms are often too slight to call attention to the chest. The diagnosis should embrace the particular etiologic variety (*e. g.*, tuberculous pleurisy, streptococcus, or pneumococcus pleurisy) by a bacteriologic examination of the exudate. The chief difficulties are encountered in distinguishing this affection from conditions in which the lung is either consolidated, retracted, or compressed by solid new growths or a serous transudate. Chief among the former is *croupous pneumonia* (especially in pleuritic exudates of moderate degree), and I have tabulated below the most important distinctions between it and pleurisy. The reader will be further aided by comparing Fig. 47 with Fig. 10, on page 113, since these show the physical conditions in the two diseases.

PLEURISY WITH EFFUSION

PRIMARY LOBAR PNEUMONIA

Rational Symptoms

Onset marked by repeated chilliness.
The pain is sharp, "stitch-like," and strictly localized.
Cough irritating; no expectoration, or catarrhal.
Sputum rarely shows tubercle bacillus.
Moderate fever of continuous type; decline by lysis.
Systemic prostration (moderate).
Countenance pale and anxious.

Herpes does not appear.
Leukocytosis absent or slight.

Onset acute, rigor, lasting one hour.
Acute pain (similar), but soreness more diffused.
Cough more marked and accompanied by rusty or bloody expectoration.
Shows presence of pneumococcus.
Intense fever; decline by crisis from the fifth to the ninth day.
Prostration marked.
Countenance congested; mahogany flush on the cheeks.
Herpes quite common.
Leukocytosis usually marked.

Physical Signs

Inspection.
Distention of the thorax.
Apex beat displaced.
Palpation.
Diminished or absent tactile fremitus.
Percussion.
Flatness, with great resistance to the pleximeter-finger.
Shows displacement of neighboring organs.
Grocco's sign usually present.
If the sac be partly filled, line of flatness changes in varying the position.
Auscultation.
Bronchial breathing frequent, but diffused and distant and unaccompanied by râles, as a rule.
Vocal resonance may be diminished; egophony.
Friction-sound in early and late stages.
Yields serum upon exploratory puncture.

None.
Not displaced.

Marked tactile fremitus (absent only when a bronchus is plugged).

Dulness less wooden, less resistance, and sometimes a tympanitic note.
No displacement of neighboring organs if uncomplicated. Grocco's sign absent.
Absent.

Harsh bronchial breathing and presence of râles in first and third stages, unless a bronchus be plugged.
Bronchophony (loud), unless a bronchus be blocked.
No friction-sound, except crepitant râles in the first stage.
Yields a few drops of thick blood.

Consolidation of the lung, due to tuberculous infection, may be differentiated by means of the physical signs contrasted in the foregoing table, the history of the case, and by the discovery of the tubercle bacillus in the sputum.

Hydrothorax presents physical signs that simulate strongly those of pleural effusion. Hydrothorax, however, gives the history of cardiac or renal disease, is oftener bilateral, and is unassociated with a rise in temperature or with the pain or friction-sounds peculiar to pleurisy. The laboratory examination of the fluid removed by aspiration will distinguish between that of the exudate

Treatment.—In the first stage the treatment is the same as for dry or plastic pleurisy. During the second stage, that of effusion, the objects of treatment are threefold: (1) To limit the extent and intensity of the inflammatory process; (2) to accomplish the removal of the effusion, and (3) to support the strength of the patient.

(1) **To Limit the Extent and Intensity of the Inflammatory Process.**—To this end two classes of agents are employed, namely, (a) *Internal*, and (b) *External*.

Among the latter are counterirritants, as sinapisms and iodine, by means of which constant counterirritation is to be maintained. Another agent of great worth is cold, applied by means of the ice-bag or ice-water bag, and if the temperature rises to 102° F. (38.8° C.) cool spongings of the surface of the body, together with the use of the ice-cap, are useful. The affected structures are kept at complete rest to relieve the pain by mechanical fixation of the side affected with adhesive plaster.

The use of drugs internally in the treatment of the general symptoms of a pleural effusion has but little effect. Salicylates have been used and quinine as well. Diaphoretics, diuretics, and mild salines are indicated in order to promote proper secretion and excretion. With a subsidence of the inflammatory process the temperature falls, and then our efforts should be directed toward the fulfillment of the second leading indication, (2) the removal of the effusion.

Little is to be accomplished by local means, though iodine, persistently employed, sometimes does good. Blisters are not admissible.

With small effusions, mild hydragogue cathartics, and especially the salines, after the Matthew Hay method (*i. e.*, 3ij to 3ss—8.0–16.0, in the smallest possible amount of water, on rising in the morning), stimulate absorption from the pleural cavities by draining the blood of a certain amount of serum.

The patient may be put upon a dry diet in order to increase the plasticity of the blood, which is thus induced to absorb the liquid exudate from the pleural cavity.

These methods are advisable when a small effusion exists. The withdrawal of the liquid by aspiration (thoracentesis) is so easily and readily done that it is advisable in the great majority of cases, especially because about one-third of all pleural effusions are not spontaneously absorbed and because there may be left extensive adhesions when the fluid is gradually absorbed. The fluid should be withdrawn under any circumstance where there are (1) bilateral effusions; (2) pressure-symptoms, such as orthopnea, cyanosis, cardiac distress.

The operation is free from danger if carried out under aseptic precautions. The instrument should always be tested before it is used. The patient rests in bed in the semirecumbent posture, the arm of the affected side being brought forward with the hand placed on the opposite shoulder, so as to separate the ribs from one another. The point of puncture is in the sixth interspace on the right side and the seventh interspace on the left, in the midaxilla, or just below the outer angle of the scapula in the seventh right and eighth left interspaces, respectively. Local anesthesia by means of the intradermic injection of cocaine (2 per cent. solution) is strongly advised. An assistant draws up the skin from the interspace, while the operator uses the forefinger of his free hand as a director. The needle should be introduced with a quick thrust, hugging the rib below the interspace, but endeavoring to avoid striking its periosteal covering. The fluid may not be obtained at the first operation, and the reasons for this failure are several. The costal pleura may be excessively thickened, or we may meet with a much-thickened fibrous band. Again, the fluid may be encapsulated; and, lastly, the needle may become blocked,

smaller proportion of cases the exudate is fibrinopurulent. *Microscopically* the inflammatory products are identical with those of purulent inflammation in general. The pleural membranes are the seat of a more intense inflammation than in acute serofibrinous pleurisy, and are greatly thickened (1 to 2 mm.). They present a granular suppurating surface, and both visceral and costal pleurae may exhibit perforations, and the latter, often erosions.

Histologically, the altered membranes consist of new connective tissue, new blood-vessels, and numerous leukocytes.

Etiology.—The following are the chief circumstances under which empyema arises: (1) As a sequel of the acute, serofibrinous variety. However clear the effusion may be, it always contains corpuscular elements, which in the further progress of certain cases undergo coincident increase in numbers until the effusion presents a milky aspect, when it is said to be purulent. Thoracentesis may be responsible for this change, though never if performed under rigid aseptic precautions.

(2) In children the effusion early becomes purulent in many instances. Melville-Dunlop's statistics indicate a proportion of 1 case of empyema to every 8 or 9 cases of pneumonia among children.

(3) Secondary to the acute and chronic infectious diseases—*blood metastasis* (pyemia, scarlatina, pneumonia, tuberculosis, and dysentery most frequently; typhoid fever, measles, whooping-cough rarely).

(4) Secondary to malignant affections of contiguous organs (lungs, esophagus), or tuberculous cavities which perforate the pleura. Rarely, carious ribs and vertebræ may cause empyema.

(5) Lymphatic metastasis is probably an important means by which bacteria reach the pleura from neighboring but not contiguous tissues (McFarland).

(6) Injuries to the chest may set up empyema (fracture of the ribs, stab or other penetrating wounds).

Bacteriologic investigation has shown that the organisms most frequently present are the pneumococci, streptococcus, staphylococcus, and tubercle bacillus. The cases due to pneumococci usually pursue a favorable course. The *Leptothrix pulmonalis* is often found in putrid effusions.

Clinical History.—The symptoms vary with the cause. The *onset* may be characterized by acute symptoms (*e. g.*, streptococcus empyema), such as rigor, followed by high temperature and signal prostration, and in the affected side there may be severe pains, aggravated by deep breathing and bodily movements.

If the exudate becomes gangrenous, a *typhoid state* develops early, and the case is apt to prove fatal in the course of a few weeks. It is quite a common event for the acute symptoms that characterize the invasion to be replaced at the end of a week or more by the more obscure rational symptoms of chronic empyema. The latter, however, may develop very insidiously as a secondary affection. The rational symptoms in a well-marked case should always excite a suspicion of the presence of the affection, but cannot settle the diagnosis. The *local symptoms* (pain, cough, and expectoration) are of a mild character; dyspnea may be more or less intense. I have on more than one occasion found an utter absence of these symptoms. The *general symptoms* are those of septic infection—diurnal chills occurring at irregular intervals, followed by intense paroxysms of fever and profuse sweating—and such patients rapidly lose flesh and grow pale and weak. The temperature is higher than in pleurisy with effusion and is intermittently, though irregularly, elevated.

Blood examination invariably shows leukocytosis, often of high degree. The roentgen ray gives very positive information as to the location and size of the empyema.

to be: (1) a copious effusion; (2) paresis of the intercostal muscles, inducing relaxation of the thoracic wall; (3) a somewhat forcible heart-beat (Henry). The rational *symptoms* of empyema are present. The *physical signs* are also identical with those of the latter affection, with the pulsation superadded. There are instances in which palpation alone detects the systolic pulse in the pleural effusion. With rare exceptions the effusion occupies the left pleural sac. The pulsation may be limited to two or three interspaces, or it may be visible over the entire anterolateral aspect of the chest; pulsation at the back, however, is rare.

Differential Diagnosis.—An absolute distinction between empyema and *pleurisy with effusion* rests solely upon the results of an aseptic exploratory puncture. For this purpose the needle attached to the ordinary hypodermic syringe or, preferably, the surgeon's exploring needle may be employed, withdrawing but a very small quantity of the fluid, which, if purulent in character, should be examined bacteriologically.

Pulsating pleural effusion simulates closely *aneurysm of the thoracic aorta*. When pulsation occurs in empyema, however, it is seen to be to the left of the normal course of the aorta: the rational symptoms and usual physical signs of purulent pleural effusion are usually present also, while the vascular symptoms and signs of aneurysm of the aorta (thrill, bruit) are absent.

Prognosis.—Empyema is a serious disease, but, obviously, the outlook will be modified by the special etiology. Spontaneous absorption may occur, though it is extremely rare. Rupture into the bronchial tubes is a comparatively favorable event, some cases in which this occurs recovering, while in others death follows in consequence of the sudden inundation of the bronchi. An empyema may, in rarer cases, empty itself externally with favorable issue (*empyema necessitatis*). Evacuation of the pleural cavity is often followed by a continuous discharge of pus for an indefinite period. As a result of the long-continued suppurative process death may take place by slow asthenia. It must not be forgotten, however, that an unfavorable termination may be, in part at least, ascribable to certain associated affections (phthisis, pericarditis). Double empyema, fortunately a rare condition, is exceedingly grave.

Among children the outlook is much more favorable than among adults. The prognosis has been rendered less serious by the application of surgical principles in the treatment of the disease. In all cases of recovery there is a progressive obliteration of the pleural cavity owing to adhesions, which finally become universal and lead to marked retraction of the affected side (*pleuritis retrahens*).

The **treatment** of empyema is chiefly surgical. In a child, especially in empyema following pneumonia, recovery may follow one or more tapplings. Occasionally such an event takes place in an adult. In the vast majority of cases, however, free drainage should be provided at the earliest possible moment. The large number of deaths of soldiers with empyema following radical operative procedure, at the cantonments in this country during the World War, and the crippling after-results showed the necessity of some other type of operation. After much experimentation throughout the country by many medical men a technic was involved which has given splendid results both in the mortality rate and in preventing collapse of the lung and the formation of extensive adhesions. In brief, this method consists of the introduction of a trocar and cannula into the abscess cavity. The trocar is withdrawn, care being taken to prevent air entering the pleural cavity, and rubber tubing inserted. The cannula is attached to the chest wall and the rubber tubing connected up to a Y tube which, in turn, runs to a bottle of Dakin's solution and to a suction apparatus. With this rather complicated apparatus it is possible to

(b) **CHRONIC DRY OR ADHESIVE PLEURISY.**—(1) This may succeed the acute or chronic serofibrinous pleurisy. If the liquid portion of the exudate is absorbed the pleural membranes come into more or less close apposition, being separated only by fibrinous elements that become organized into a layer of firm connective tissue. Hence the two layers of the pleura, that are greatly thickened, cannot be separated, owing to the firmness of the adhesions. In most cases the autopsy shows the latter condition to be most pronounced at the base, while the lung is found to be compressed and the seat of fibroid change. If it follows the acute form the extent of retraction is slight, since there are no dense fibrous bands to prevent a fair degree of lung expansion; if it succeed the chronic form, however, or empyema, the extent of retraction and flattening will be quite marked. The exudate may undergo calcareous degeneration, and occasionally little pouches of fluid may be found between the false bands.

(2) There is a large class of cases that are dry from the onset (*idiopathic dry chronic pleurisy*), and this variety may either be a sequel of acute plastic pleurisy or primarily tuberculous. The condition is very commonly met with at autopsy in subjects who during life had never presented symptoms of pleurisy with effusion. The plastic exudate, however slight, invariably tends to become organized, with resulting fibrinous adhesion of the two layers of the pleura. Most generally the adhesions are circumscribed, and if tuberculous in origin are most frequently apical and often bilateral. Under these circumstances small caseous masses and little tubercles may be found embodied in the somewhat thickened pleura. General synechia is, however, not rare, particularly unilateral.

Symptoms.—Definite rational symptoms are rarely present, and the physical signs lack uniformity or may be entirely negative. In other cases of a mild grade the main characteristics are restrained mobility of the affected side and feebleness of the respiratory murmur. In rarer cases the weakness of the breath sounds is out of all proportion to the expansive motion of the chest. In still another category—composed of a considerable number of instances—certain physical signs are quite pronounced. Inspection reveals decided contraction, with immobility of the affected side and a compensatory distention of the healthy side. The heart is displaced, and the apex-beat may be missing (*e. g.*, when the heart is drawn or pushed behind the sternum or overlapped by the emphysematous lung). The spinal column is curved, the scapula dislocated, the shoulder ill-shapen and drooping, and the lower part of the thorax shrunken, while the ribs are obliquely placed and closely approximated, or even overlap one another. The tactile fremitus is decreased or absent over the lower portion of the chest, and there is impaired percussion resonance or dulness over this area. The breath sounds on auscultation are exceedingly feeble, and in some cases an occasional dry, leathery, or creaking friction-sound is audible.

The roentgen ray is at times of value in determining the extent of the fibrosis, but frequently the parietal pleura is so thickened that its shadow obscures all lying beneath it.

Rarely, and particularly if the case be tuberculous, vasomotor symptoms arise in chronic pleurisy, such as unilateral flushing or sweating of the face, or dilatation of the pupil.

Doubtless some instances of chronic pleurisy merge into the pleurogenous type of cirrhosis of the lung, and fatal complicating conditions may arise in connection with the general circulation. Thus, I have observed in one instance enlargement followed by dilatation of the right ventricle, and, in turn, by general dropsy, with fatal result.

In the treatment of this affection two objects must receive especial attention: (1) the removal of any effusion that may be present; and (2) the

improvement of the nutrition of the patient. The first indication is presented only by a limited number of the cases, and the rules for meeting it have been stated in the treatment of serofibrinous pleurisy and empyema; the second indication is presented by all cases. Careful regulation of the diet is of the utmost importance: it must be generous. Lung gymnastics are most useful if methodically pursued. The method of Ralston James (previously described) richly deserves a trial in suitable cases. It is to be borne in mind, however, that in old cases efforts at overcoming the lung pressure will be unsuccessful. Climatotherapy is advantageous, particularly if tuberculosis exists; and in my own experience low, mountainous elevations combined with purity of atmosphere have given the best results. Of medicines little need be said. It is especially important to promote the digestive power of the patient to the greatest possible extent. In cases in which the digestive function has been feeble I have observed excellent results from a brief stay at any well-regulated seaside resort or in the country. We may also use, with a probability that the effect will be beneficial, small doses (3j—4.0) of cod-liver oil three times daily after food, or the following formula:

R. Pepsini, 3ij (8.0);
 Acidi hydrochlor. dil., f3iiss (10.0);
 Tinct. nucis vomicæ, f3iiss (6.0);
 Elixir digestivi co., q. s. ad f3ij (60.0).—M.
 Sig. Teaspoonful in water after meals.

Intercurrent catarrh of the stomach may sooner or later become a troublesome feature, and in combating it lavage is frequently our most effective measure.

PNEUMOTHORAX

(*Seropneumothorax*; *Pyopneumothorax*)

Definition.—A collection of air in the pleural cavity. Since the latter, as a rule, contains at the same time serum or pus, the terms sero- and pyopneumothorax are frequently employed to describe the same condition. It is an uncommon condition.

Pathology.—When the pleural sac is punctured air usually escapes, accompanied sometimes by an audible hissing sound. The pleural sac in pure pneumothorax is greatly distended, and the lung is impacted against the spinal column. Other organs (spleen, heart) are also displaced owing to positive intrathoracic pressure. The heart is not rotated, however, and the relation of its parts is maintained much as in the normal condition (Osler). The air may occupy but a portion of the pleural cavity on account of previous firm adhesions (*circumscribed pneumothorax*). The point of perforation, as a rule, can be easily found, and frequently corresponds to the seat of rupture of the tuberculous cavity or superficial caseous mass. In other instances the cause of pneumothorax cannot be discovered. Inflation of the lung under water may reveal the aperture, which is usually small, by the escape of air-bubbles at the seat of puncture. Occasionally a fistulous connection between the pleural sac and the bronchi can be traced.

Simple pneumothorax is, however, of rare occurrence. The air that gains admission into the pleural sac is laden with micro-organisms (*vide* Bacteriology, p. 563), which set up various forms of inflammation, accompanied by equally

rious exudations. Hence the cavity is usually filled, in part, with an effusion that is purulent or seropurulent, as a rule, and rarely serous or serofibrinous. The gas in cases of pneumothorax may be of bacterial origin; this contains substances not found in air, such as H, H₂S, or marsh gas.

Etiology.—The *predisposing* influences are: (a) *age*—the condition occurring in adults, as a rule, though instances are also observed in young children; (b) *sex*—males suffer more than females; (c) the left side is affected nearly twice as often as the right; (d) *emphysema*, in which the superficial air-sacs are dilated and atrophied, and so rendered liable to rupture from excessive muscular exertion.

The **exciting causes** are: (1) *Perforation of the lung and pulmonary pleura* (the most frequent cause), arising in one or other of three ways: (a) From the rupture of a tuberculous cavity into the pleural cavity. This accident rarely occurs at the apex of the lung, but commonly near the upper border of the lower or middle lobe; less frequently near the lower border of the upper lobe. A caseous focus immediately beneath the pleura may also, during the process of softening, puncture the pleural sac and invite the entrance of air during the early stages. It cannot occur, however, except in cases in which previous adhesions have failed to form at the point of perforation. At least 70 per cent. of the cases of pneumothorax are tuberculous (Morse); 90 per cent. (Johnston¹). (b) As the result of necrotic processes, in connection with certain other lung affections, as gangrene, bronchopneumonia, suppurating bronchial glands, abscess, and echinococcus cysts. (c) From rupture of the normal air-sacs in consequence of severe muscular effort (S. West, DeH. Hall). This accident is sometimes ascribable to the violent paroxysms of cough in pertussis.

(2) Some cases of *empyema*, by perforating the visceral pleura, the lungs, and bronchi.

(3) Perforations of the pleura in *malignant disease* and *abscess of the esophagus*.

(4) A *peripheral bronchiectasis* may open the pleural space.

(5) Pyopneumothorax may be of *subdiaphragmatic origin*, consecutive to perforation by *malignant disease* or *ulcer of the stomach or colon*.

(6) Pneumothorax may be occasioned by *gases* resulting from the action of a gas-forming bacterium on the pleural exudate.

(7) *Wounds* causing direct or indirect perforative lesions of the lungs. Fractures of the ribs may produce laceration of the visceral pleura, and allow the air to enter the pleural sac.

(8) English and French authors and, more recently, Americans as well have emphasized the occurrence of a benign spontaneous, non-tuberculous pneumothorax, "occurring in apparently healthy individuals without ascribable cause, resulting in no infection of the pleura and, therefore, unaccompanied by constitutional symptoms and healing rapidly and completely in a few weeks" (Hamman²).

Symptoms.—The earliest symptoms vary according to the cause or causes that produce the condition. When it develops, as it does so often in the course of pulmonary tuberculosis, the *onset* is sudden, marked by agonizing pain in the side, by intense *dyspnea*, and frequently *cyanosis*. The dyspnea is often accompanied by a sense of impending suffocation. The severity of the pain and the degree of oppression depend largely, however, upon the amount of air that gains entrance into the pleural sac or is formed from the exudate, the rapidity with which it enters, and the presence or absence of previous pleuritic adhesions. If the orifice be large and valvular, the air cannot escape, but rapidly accumulates and forces all the air out of the lung by compression; the patient then sinks rapidly into collapse from shock and sudden death.

¹ *Amer. Jour. Med. Sci.*, 1919, clviii, 105.

² *Ibid.*, 1916, cli, 229.

be in abeyance for several days (masked pneumothorax). *Inspection* shows marked distention and immobility of the affected side; also some degree of distention with unnatural mobility of the healthy side.

Palpation shows the tactile fremitus to be diminished above and greatly diminished or wholly absent over the effusion below. Edema of the chest wall can frequently be made out. The impulse-beat of the heart is found to be feeble and displaced.

On *percussion* a deep and full or modified tympanitic note (*bell tympany*) can usually be elicited over the area corresponding to the contained air, and the excessive tension in the pleural sac, due to the enormous amount of air it contains, may cause an elevation in the pitch of the note even to dulness. The "cracked-pot" sound is audible when the air in the pleural cavity freely communicates with the external air. Wintrich's sign, or a change in the pitch of the percussion sound when the mouth is open or closed (being lowered when the mouth is closed and raised when open), may also be observed. In *pyopneumothorax* a flat note is elicited from the base upward as far as the fluid extends, and change of posture causes a more marked temporary variation in the upper level of flatness than occurs in pleurisy. Modifications in the pitch of the percussion sound result from an alteration in the form as well as in the dimensions of the air space. Owing to displacement of the heart there is, as a rule, resonance over the normal cardiac region, and particularly when the patient assumes a recumbent posture. The pulmonary resonance on the affected side is stationary and extends as low as resonance on the opposite side upon deep inspiration. There is no respiratory variation (Hamman). The liver and spleen, according to the side affected, are displaced downward to a greater degree than in simple pleuritic exudates.

Auscultation discloses a greatly weakened or altogether suppressed respiratory murmur when collapse of the lung is incomplete. Amphoric breathing is audible in cases of *open* pneumothorax, and bronchial râles possessing a metallic quality are sometimes heard, as well as metallic tinkling on deep inspiration or on coughing. The metallic tinkling is caused frequently by drops of fluid falling from above upon the surface of the effusion; less frequently by a re-echoing of vibrations of moist bronchial râles communicated to the air in the pleural chamber. The vocal resonance is enfeebled, as a rule, and evinces the same metallic quality. The so-called coin-test is a pathognomonic sign, and is elicited in the following manner: An assistant places one coin on the front of the chest and taps it with another while the ear of the examiner is placed on the thorax posteriorly, where will be heard the intensified echo of the coin sound thus produced. Another most characteristic sign is the so-called Hippocratic succussion, which is elicited by placing one ear upon the patient's chest while the latter's body is shaken, when a distinct splashing sound is heard.

Diagnosis.—When the attack is of ordinary severity pneumothorax is diagnosed by the history of one or other of the causal factors, together with certain physical signs that do not belong to any other affection (*coin sound, succussion-splash*). The sputum test and also bacteriologic study of the aspirated purulent exudate with a view to determining the special etiologic variety present in a given case is of the greatest importance. Spontaneous pneumothorax yields a sterile exudate, if any. It is only when the air and fluid in the pleural sac are encapsulated that it may become difficult to eliminate without the aid of the roentgen ray (a) a large pulmonary cavity; (b) excessive gaseous distention of the stomach; (c) an abscess below the diaphragm into which air has entered (*pyopneumothorax subphrenicus*); (d) a diaphragmatic hernia; (e) emphysema, and (f) pleurisy with effusion.

(a) *A Large Pulmonary Cavity.*—The “cracked-pot sound” and Wintrich’s sign are more frequent in cavity than in pneumothorax, and the former condition does not tend to dislocate the adjacent organs. There is an absence of the succussion-splash, and, except in rare instances of the coin-test, these signs are often present, even in circumscribed pyopneumothorax. Tabulated, these points of difference are—

PYOPNEUMOTHORAX

Immobility and bulging of the interspaces. The apex-beat is usually displaced.

Diminished vocal fremitus

Percussion-note deep and full. The effusion sinks to the base, and yields flatness, the outline of which changes with the posture of the patient.

Respiratory murmur and vocal resonance usually absent. Amphoric breathing may be heard if the opening in the lung is patulous. The coin-sound and Hippocratic succussion-splash are noted.

LARGE PULMONARY CAVITY

Immobility, flattening of the chest, and depression of the interspaces. Apex-beat not displaced.

Fremitus usually increased.

Percussion gives tympany or a “cracked-pot sound,” and Wintrich’s change of sound as a rule.

Bronchial breathing is heard, and the vocal resonance is increased. Crackling, gurgling râles, cavernous or amphoric breathing, and pectoriloquy may be present. Absence of bell-tympany (generally) and succussion-splash.

(b) *Excessive gaseous distention of the stomach* is to be eliminated by the history of the case and by the results of the application of the therapeutic test, evacuation of the stomach and bowels.

(c) *Subphrenic Abscess Containing Air.*—This is exceedingly rare, and occurs relatively oftener on the right than on the left side (Leyden). Its leading causes are ulcers of the stomach or duodenum, followed by circumscribed peritonitis, perforation, and abscess, the latter occupying a position immediately beneath the diaphragm and above the liver. The gases that gain admission to the abscess sac from the intestines force the diaphragm upward, and thus cause retraction or even compression of the lung. The symptoms are not identical with those of circumscribed pyopneumothorax, limited to the base. A knowledge of the steps in the production of subphrenic abscess; the absence of cough and expectoration, and of marked displacement of the heart; and the presence of bulging of the hypochondrium, of striking depression of the liver, and of Pfuhr’s sign (*q. v.*), are indications favoring subphrenic abscess.

(d) *Diaphragmatic Hernia.*—This either results from a severe injury or is congenital, and the most valuable point of difference between hernia of the diaphragm and pneumothorax is the peculiar cause of the former. The next most valuable point is the fact that the hernial protrusion may return suddenly to its normal position, whereupon the patient will be relieved; the condition may then reappear not less suddenly. The third distinctive feature is the presence of rumbling sounds in the protruded bowel. All other signs and symptoms of one affection may have their counterparts in those of the other.

(e) Pneumothorax may be confounded with *emphysema* by the careless observer; but the latter affection is slow in onset, free from serious shock, is bilateral as a rule, and does not exhibit the distinctive physical signs of pneumothorax (metallic tinkling, coin-sound, succussion-splash).

(f) In *pleurisy with effusion* hyperresonance may be noted above the fluid, but it lacks the bell-like tympany of pneumothorax. Over the same area there is diffuse, distant, bronchial breathing (at times slightly amphoric), while the metallic tinkling, coin-sound, and succussion-splash are totally wanting.

Prognosis.—This depends largely upon the cause. Spontaneous pneumothorax often heals rapidly. The cases attributed to advanced phthisis usually

ach a fatal issue in the course of one, two, or more weeks, and rarely they run very rapid and fatal course. On the other hand, the pulmonary condition at times favorably influenced by its occurrence. Following empyema, or when due to trauma or abscess of lung, pneumothorax sometimes takes a favorable course. It is fraught with especial danger when it is the resultant condition of some acute lung disease (gangrene, bronchopneumonia). The prognosis is worse in right-sided pneumothorax.

Treatment.—The leading indication is the alleviation of the patient's sufferings by a prompt resort to morphin, and it often becomes necessary to administer it hypodermically. If the patient's previous strength has been moderately good, the question of operative intervention should be seriously considered, the nature of the surgical procedure then depending upon the character of the effusion. If this be serofibrinous, aspiration, as in simple pleurisy, must be performed to relieve the urgent dyspnea; if purulent, permanent drainage should be procured for the same indication. A costal resection may be advisable. When pneumothorax develops late in phthisis radical measures are not to be thought of, and the physician must rely upon aspiration (when necessary) to relieve urgent symptoms. We may also tap the air-chamber above the fluid with a fine needle, with a view to lessening the excessive tension. Unverricht has recently reported good results from a somewhat novel mode of treatment. When there is a pulmonary fistula present he inserts a tube into the pleural sac. This allows free entrance of air, the lung collapses completely, and the fistula has a chance to heal. Pisani¹ used counter-pressure from injected nitrogen in spontaneous pneumothorax, the perforation in the lung tissue being closed. For the dyspnea, atropin administered hypodermically is valuable; for the feeble cardiac action, alcoholic stimulants, aromatic spirits of ammonia, strychnin, ether, and other stimulants should be employed. Locally, cutaneous irritants may be applied (turpentine stupes, mustard pastes).

HYDROTHORAX

(Dropsy of the Pleura; Thoracic Dropsy)

Definition.—A collection of transuded serum in the pleural cavity.

Pathology.—Hydrothorax is generally a bilateral condition. The transudate is a clear, amber-colored liquid that is free from fibrin, but may contain cholesterin and a few endothelial cells. It has an alkaline reaction, a comparatively low specific gravity (1009 to 1012), and is non-inflammatory. The pleural surfaces are usually smooth, though sometimes decidedly pale and edematous. The mechanical effects of hydrothorax upon the lungs and other thoracic and abdominal viscera are similar to those of the exudates that accompany inflammation of the pleura, though they are rarely so marked as in serofibrinous pleurisy.

Etiology.—Hydrothorax is a secondary affection, and is usually connected with one or other of the various forms of general dropsy (hemic, renal, cardiac). The condition may develop at a comparatively early stage of arteriosclerosis and of chronic valvulitis, especially aortic incompetency, without external dropsy. Of 608 cases of hydrothorax, 294, or 48.3 per cent., were of cardiac origin. Again, of these 294 cases, 190, or 64.6 per cent., were associated with myocardial, and 107, or 35.4 per cent., with valvular heart disease. In 162, or 85.3 per cent., of the myocardial cases marked sclerosis of the vessels coexisted, while in 28, or 14.7 per cent., a slight grade of arteriosclerosis was associated. In nearly all of the myocardial cases evidence of chronic inter-

¹ *Gazzetta degli Ospedali e delle Cliniche*, Rome, March 23, 1916.

stitial nephritis was also present (Anders¹). The cases that are due to blood impoverishment are more numerous than is generally indicated by writers upon the subject, and not infrequently is hydrothorax secondary to either chronic dysentery, chronic diarrhea, leukemia, pernicious anemia, carcinoma, malaria, syphilis, or scurvy. Strictly local causes may also induce it, as carcinoma of the pleura, or compression of the superior vena cava or of the thoracic duct by a tumor. Fetterolf and Landis have demonstrated that the fluid comes from the visceral, and not the parietal pleura, including the azygos veins.

Symptoms.—The *subjective symptoms* are attributed to the mechanical effects of the fluid, and may be quite in common with those of the causal affection; there are *dyspnea* (often culminating in orthopnea), *cyanosis*, *asthmatic seizures*, *irritative cough*, and a *feeble circulation*. The *general symptoms* arise from the primary affection.

The **physical signs** are much the same as in pleurisy with effusion—with this difference, that they are more often bilateral. Hydrothorax is often unilateral, however (59, or 31 per cent., of 190 cases—Anders), and an enlarged right auricle may be the cause of this condition in some instances. The right side is the one usually affected. I have also observed that quite frequently the two sides of the chest exhibit great variations as to the relative amount of fluid contained.²

Diagnosis.—While this rests almost exclusively on the physical signs, these must be carefully noted, or otherwise the condition will sometimes escape detection. The diagnosis should embrace the particular etiologic variety so far as practicable, *e. g.*, if cardiac. With respect to myocardial hydrothorax, the principal error in diagnosis is in the assumption "that the condition is not to be suspected in cases in which the signs of chronic valvulitis and external edema are absent" (Anders³). In this variety such clinical features as arrhythmia and more or less hypertension may also be present.

Prognosis.—This depends upon the nature of the primary disorder that causes the dropsical transudation.

The **treatment** of hydrothorax has intimate relations with the indications presented by the underlying affection. If the measures directed toward the removal of the general dropsy (*anasarca*), of which hydrothorax is a part, are unsuccessful, and the amount of transudation in the pleural sac interferes with the functions of the heart and lungs, then aspiration must not be too long delayed, and must be repeated as often as occasion demands. Experience teaches that aspiration should precede the use of cardiac stimulants in hydrothorax, since the latter tend to aggravate the dyspnea when considerable serous fluid is present in the pleural sacs. In double hydrothorax it is wise to aspirate both sacs at one and the same sitting, since unilateral tapping affords insufficient relief.

CHYLOTHORAX

Definition.—Chylothorax is an accumulation of chyle within the pleural cavity. Baldwin has collected 47 cases and Lewin has recently reported an instructive case.

Etiology.—It may be caused by rupture of the thoracic duct or its radicles, due to chest injury, or to some diseased condition of their walls permitting of

¹ "A Statistical Study of Hydrothorax; Its Diagnosis and Treatment," *Pennsylvania Med. Jour.*, February, 1914.

² For the differential diagnosis between pleurisy and hydrothorax, see Pleurisy, p. 573.

³ "Myocardial Hydrothorax," *Amer. Jour. Med. Sci.*, July, 1913.

transudation into the pleural sac. It is not infrequently secondary to new growths, either without or in the duct.

The symptoms and signs are those of hydrothorax (*vide ante*), although few patients complain of pain in the affected side if the condition is unilateral.

The diagnosis depends wholly upon the chylous nature and appearance of the transudate.

The prognosis is unfavorable, although the condition is by no means always fatal.

The treatment of chylothorax is governed by the special cause in the given case. "In those cases due to chronic obstruction, aspiration, rest in bed, and nourishing food are indicated" (Levin). Not all of the fluid should be removed at once in cases which demand paracentesis.

NEW GROWTHS OF THE PLEURA

Almost all instances of new growths developing in the pleura are secondary to primary carcinoma of the lung, the pleura being invaded by the direct extension of the neoplasm. It may also arise by metastasis from carcinoma of the lung, mammary glands, etc. The pleura presents circumscribed areas of thickening, or the growth takes the form of papular projections from its surface, becoming pedunculated as they enlarge. Their size varies from that of a pea to that of an orange. The adjacent pleura is inflamed, often adherent, and much thickened, and an effusion into the pleural cavity is often observed.

Primary carcinoma of the pleura is very rare indeed, and E. Wagner, who first described it, called it endothelial carcinoma. Most pathologists of today, however, look upon endothelioma as a variety of sarcoma. It owes its origin to a proliferation of the endothelial cells of the connective tissue and the lymph apparatus of the pleura. This invariably assumes the diffuse form, and by metastasis we have involvement of the other organs (lungs, lymphatics, liver). Spindle-cell sarcoma and the round-cell variety are occasionally met with.

Symptoms.—The subjective symptoms are slight in cases in which there is a single circumscribed carcinomatous mass in the pleura; but they are quite severe in the diffuse form, particularly when, as commonly occurs, it is of a secondary nature. The symptoms are now those of plastic or serofibrinous pleurisy, in addition to those of primary carcinoma of the lung, and the former may oftentimes more or less completely overshadow the latter.

Diagnosis.—The circumstances under which the condition arises often throw the strongest light upon its nature. The symptoms of slowly developing pleurisy, either plastic or serofibrinous, following carcinoma of the lung or the breast, and accompanied by the cancerous cachexia, would point strongly to the existence of carcinoma of the pleura. Characteristic cancerous elements may also be found by microscopic examination of the usually hemorrhagic fluid obtained on aspiration. The exudate contains fatty endothelial cells. Mitotic figures in cells of serous exudates are of confirmatory diagnostic value.

The difficulties surrounding the diagnosis of primary carcinoma of the pleura are great and usually insurmountable. The cases are very similar in their clinical manifestations to chronic pleurisy with or without effusion. Pain is always a more prominent symptom, however, than in simple chronic pleurisy, and this fact, when combined with evidences of a cancerous cachexia, should excite strong suspicions. The prognosis is wholly unfavorable and the treatment merely palliative.

the following ratio: of carcinoma, 134; sarcoma, 98; lymphoma, 21; fibroma, 7; dermoid cyst, 11; hydatid cyst, 8; and fewer cases of ecchondroma, lipoma, and gumma. In 48 of the cases of carcinoma and in 33 of sarcoma the tumor occupied only the anterior mediastinum. It is quite probable, however, that sarcoma, and not carcinoma, is the commoner neoplasm of this region. The clinical term "cancer" was formerly used promiscuously by many authors, and the pathologic diagnosis was then difficult, so that statistics are scarcely trustworthy. Upon investigating 25 of the older reports of "cancer," Pepper and Stengel found in 13 unquestionable evidence that the growth was sarcoma, while in the remaining 12 they could not, for the greater part, decide to which form the disease belonged. Primary sarcoma may spring from the remnant of the thymus gland, from the lymphatic glands, the pleura, or lungs, or from the fibrous tissues of the mediastinum. Primary carcinoma may originate in the esophagus, bronchi, lungs, or rarely in the thymus gland. Secondary mediastinal tumors are apt to have their seat in the lymphatic glands. Carcinoma is less frequently primary than sarcoma. Among *predisposing causes* are sex and age—males being more prone to the affection than females, and the period of chief liability is between the thirtieth and fortieth years.

Symptoms.—The earlier symptoms are vague (slight substernal pains, dyspnea, languor). Later, pressure-symptoms gradually arise.

The *pain* may or may not be severe, but is invariably accompanied by a feeling of oppression. Its chief seat is in the upper sternal region, but it may radiate to the sides of the chest and even down the arms (due to pressure on the brachial plexus). *Dyspnea* appears early, is constant, and may become intense. It is caused by pressure either upon the trachea, upon a primary bronchus, or upon a recurrent laryngeal nerve. *Asthmatic seizures* may occur before there is constant dyspnea and before the tumor has reached notable size. There is *cough*, which may be paroxysmal and of a brazen character. Aphonia may be present. There may be *dysphagia* from pressure upon the esophagus, though this is rare. If there is an inflammation of the vagus or sympathetic nerve, the rate of the pulse may be either slowed or markedly quickened. Owing to implication of the sympathetic there may be local hyperemias and pupillary inequalities.

Compression of the superior vena cava or of the subclavian vein may be followed by cyanosis and edema of the parts drained by these vessels. The early occurrence of venous occlusion and dilatation of the superficial veins is quite characteristic. Collateral circulation may be rarely established. Less frequently the inferior cava may also be compressed.

Physical Signs.—*Inspection.*—In advanced cases a swelling, usually somewhat irregular and often diffuse, appears in the sternal region. The tumor may cause erosion of the sternum, and a little later occupy a position immediately beneath the skin. I saw a case in which the perforation occurred at the right edge of the sternum where aneurysms of the ascending arch appear. In the early stages, however, this prominence is not present. *Palpation.*—When a tumor is present it may pulsate distinctly, and the heart's apical impulse may be detected in various abnormal positions. Tactile fremitus is feeble or absent over the seat of the growth.

On *percussion*, dulness is noted, and this is true even in many instances that do not present a visible swelling. The dull area varies in outline with the size and position of the tumor. *Auscultation* usually reveals no sounds over the dull area except a bruit in rare instances. The heart-sounds are inaudible over the tumor site as a rule, and the breath-sounds and vocal resonance are feeble or absent. To the above physical signs are frequently added those of pleural effusion.

PART VII

DISEASES OF THE CIRCULATORY SYSTEM

I. DISEASES OF THE PERICARDIUM

PERICARDITIS

Definition.—An inflammation of the serous covering of the heart.

Varieties.—(a) Plastic, or fibrinous; (b) serofibrinous, or subacute; (c) purulent; (d) hemorrhagic; (e) adhesive. There is also a tuberculous pericarditis which has been described (*vide* Tuberculosis, page 272).

Bacteriology.—Pericarditis may be caused by a great many different varieties of bacteria, chief among which are the pyogenic cocci, the organism that causes acute articular rheumatism, and the tubercle bacillus. Among other organisms, the *Bacillus coli communis*, and probably also a variety of the *Bacillus pyocyaneus* and the gonococcus may be named. Micro-organisms are not always found in pericarditic exudates by any means.

ACUTE PLASTIC OR FIBRINOUS PERICARDITIS

Pathology.—The morbid changes are frequently localized, and less frequently are general. At the onset the membrane is smooth, swollen, and injected, and punctate ecchymotic spots may be visible; soon it presents a grayish, roughened appearance from the deposit of a thin layer of fibrin. In the severer types the fibrinous deposit increases in thickness for a time, and the natural movements of the pericardial surfaces upon one another sometimes cause the exudate to assume a honeycombed appearance. Most examples that I have seen, however, have resembled the roughened surfaces produced by separating two slices of thickly buttered bread; the surfaces are grayish-yellow in color. In the later stages the exudation becomes partly organized, and, as the result of friction produced between the opposed surfaces by the incessant action of the heart, may present a villous appearance; hence the term “hairy heart” of the ancient authors. For like reasons we may see the exudate arranged in the form of little ridges, forming a “tripe-like membrane.” Though invariably present, the amount of serous effusion, as the term would indicate, is never large in dry or plastic pericarditis. Myocarditis may frequently be found as an associated condition.

Etiology.—In each variety of pericarditis there are special contributing factors, so that it is desirable to give its etiology separately, except in the serofibrinous and acute plastic types, which have practically the same etiology. The two latter are the more common forms of the disease. Acute plastic pericarditis most frequently occurs in young and middle-aged males. It may

be *primary* or *secondary*. It often occurs in acute articular rheumatism (in more than one-half the cases), chorea, lobar pneumonia, chronic nephritis, and, rarely, in other acute infectious diseases. Of 150 cases of acute pericarditis studied by Locke, pneumonia was the cause in 63 cases; empyema in 6; tuberculosis in 7; local or general sepsis in 28; nephritis in 16; meningitis in 3; rheumatism in 2. In this form the infective agents are transmitted to the pericardium by means of the circulation. It may be caused also by direct extension of inflammation from adjacent structures (secondary pericarditis), as in simple pleurisy; more commonly the extension occurs from a pneumonia or tuberculous pleurisy, or the condition may complicate new growths and inflammatory conditions affecting the esophagus and bronchial glands. It may also be secondary to chronic disease of the aortic valve, the pericardium becoming involved by extension through the walls of the aorta. Finally, it may be the result of traumatism, and this may cause any of the other forms of pericarditis.

Clinical History.—Owing to the fact that acute plastic pericarditis is usually a secondary affection, the symptoms that enable one to recognize it are obscured by those of the primary disease. This is particularly true of that large class of cases that develop in acute articular rheumatism, in which subjective symptoms are often entirely wanting. Only in the severest types of this sort are the symptoms referable to the heart well enough marked to arrest the attention. There may be a feeling of *distress* or *constriction* with or without slight *pain* in the precordium. During the first stage or prior to the pouring out of the effusion the pain is most marked, extending sometimes into the left arm or the back, and at others to the ensiform cartilage or even to the abdomen. This pain is, rarely, increased by pressure over the precordia. *Palpitation* and *dyspnea* may be present, and the *pulse* is increased in frequency and strength, as a rule, except in the later period, when it may be weak and slightly irregular, particularly if the muscular tissue of the heart be involved. There is some *fever*, but the degree of elevation of temperature perhaps never exceeds 102° F. (38.8° C.). In this class of cases the *urinary features* depend largely upon the character of the leading etiologic factors; though in many instances the urine is scanty, high colored, and acid in reaction.

Physical Signs.—*Inspection* discloses increased vigor of the apex-beat. Friction-fremitus (due to rubbing of the altered pericardial layers upon one another) may sometimes be felt during the earlier and later courses of the disease or when the membrane is comparatively dry, and is usually most intense near the base, just to the left of the sternum. *Percussion* gives negative results. *Auscultation* usually reveals a double friction-sound, sometimes quadruple (locomotive murmur)—the most important sign for a positive diagnosis. The friction-rub is caused partly by the exudate and partly by the dry state of the membrane. Its usual seat of maximum intensity is in the fourth and fifth interspaces and the adjacent portions of the sternum—*i. e.*, where the pericardial surfaces are but slightly separated from one another. Another favorite point is the cardio-aortic junction. It is usual to hear the rub over *small* areas, though occasionally it is audible over the whole precordia, and its distinguishing feature is its superficiality, seeming closer to the ear than endocardial murmurs. Pressure with the stethoscope, which approximates the layers, increases its intensity; though, if too much force be exerted, the murmur may disappear entirely. In like manner the friction-sound is influenced by respiration, losing in distinctness on deep inspiration. The quality of the sounds, like their position, exhibits great variability. They are sometimes soft; but quite commonly they are grating or rubbing, and in the later stages I have noticed that they may have a loud creaking quality. Though with few exceptions they are double, and are primarily produced by the rhythmic movements of the heart, they do not always occur synchronously with the heart-sounds, and usually

exceed the latter in duration—facts that go to show that the quality, location, or superficial area of a given murmur does not indicate the extent of the lesion. When the exudate is soft and the heart's action weak, the characteristic murmur may be absent.

Complications.—There may be an extension of the inflammatory process to the external surface of the pericardium, either from the deeper pericardial structures or from the pleura, particularly the left. This is a complicating condition termed *external pleural pericarditis* or *mediastinopericarditis*, in which the mediastinal connective tissue is also, as a rule, involved. It is most frequently secondary to tuberculous pleurisy (*tuberculomediastinopericarditis*), and sometimes also to pleuropneumonia, and rarely to simple pleurisy. The recognition of these combined lesions rests chiefly upon the detection of a friction-murmur that is partly dependent upon the cardiac and partly upon the respiratory movements. These sounds are most distinctly heard along the left edge of the heart. Momentary arrest of breathing suppresses the pleuritic friction-sound, there remaining merely the sounds produced by the rhythmic cardiac action, and even these may be absent. On the other hand, during forced respiration nothing is audible, as a rule, except the strong pleural rub. In normal respiration the inspiratory movements decrease while expiratory movements increase the intensity of the sounds. During inspiration the pulse may become small and slow, owing to the partial occlusion of the aorta, brought about by the traction of fibrous bands of adhesions which pass over the vessel, being at the same time connected with the pleura. When these bands pass from the exterior of the heart muscle or pleura, they may cause, as first pointed out by Riegel, an absence of the apex-beat during expiration. Instances of this sort are not uncommon.

Diagnosis.—Although the presence of a to-and-fro friction-sound is, as a rule, indicative of plastic pericarditis, it is an error to regard it as an infallible sign, since complete calcification of the coronary arteries, as well as excessive dryness of the pericardial surfaces, may rarely produce friction-murmurs. The etiologic factors are important diagnostically.

Differential Diagnosis.—The harsh double murmurs due to chronic *valvular lesions* can be eliminated if it be recollected that they are more constant, more distant, and that each has an area of transmission beyond the limits of the precordia. The sitting posture, leaning forward, or moderate pressure with the stethoscope, all fail to produce or to increase *endocardial murmurs*, whether acute or chronic. A double aortic murmur is associated with cardiac hypertrophy, the Corrigan pulse, and systolic flushing of the capillaries.

Prognosis.—The termination is always favorable as to life. Complete resolution does not often occur, but the exudate becomes fibrous connective tissue, and agglutinates the two layers of the pericardial sac. The acute may merge into the chronic form, and dry, plastic pericarditis often constitutes the first stage of serofibrinous and purulent pericarditis.

Treatment.—Absolute quiet should be enjoined. The diet should be composed chiefly of light, easily digested solids, and allowing little drink, thus endeavoring to avoid an overfilling of the vessels. With the same object in view, if the patient's strength be good, a half-dozen leeches should be applied over the heart, followed by the use of the ice-bag; the bowels are to be kept soluble by using stewed fruits or saline laxatives. Calomel in doses ranging from $\frac{1}{4}$ to $\frac{1}{2}$ gr. (0.016–0.032) every hour or two, combined with a little opium to prevent purgation, is serviceable. At the beginning veratrum viride may also be cautiously administered, with a view to dilating the arterioles throughout the rest of the body, and thus virtually “bleeding the patient into his own vessels.” The salicylates are indicated in cases of rheumatic origin. Tonics and a change of air may be required during convalescence.

ble, while the pulse remains strong—a valuable rational sign. On the other hand, an excessive amount of fluid may cause the radial pulse to disappear during inspiration (the *pulsus paradoxus*). Fever is present as a rule; the temperature is irregularly elevated, ranging from 101° to 103° F. (38.3°–40.4° C.). In favorable cases defervescence takes place by lysis. Nervous symptoms, as headache and mild delirium, often appear, and sometimes give place to stupor or even coma. Acute mania is rarely observed. The urine is decreased in amount, and occasionally general dropsy occurs.

Physical Signs.—Inspection.—The skin surface and mucous membranes are observed to be pale and more or less cyanotic. The neck veins are prominent, and sometimes exhibit undulatory movements or pulsations. The expression is anxious; the respirations are increased, labored, and at times irregular. Wynter has observed loss of abdominal respiratory movement. The decubitus is dorsal; the head and shoulders are elevated, and the patient may be forced to assume the sitting posture. In young subjects precordial prominence, with effacement or even bulging of the intercostal spaces, may result from the presence of a moderate effusion. In adults, however, a large collection is indispensable for the production of this effect. If the lung be shrunken or if there are pleuritic adhesions, expansion of the pericardium and, hence, also bulging will be prevented. The distended pericardium may depress the diaphragm. Elevation of the left nipple in consequence of marked anterior expansive bulging has been observed. In the first stage the apical beat is exaggerated, but as the exudate increases (forcing the heart backward and upward) it is displaced in an upward and outward direction, at the same time becoming weaker as well as more diffused, since with expansion of the sac comes greater mobility of the organ. When the pericardial sac becomes filled the impulse-beat disappears, the fluid now completely surrounding the heart.

Palpation confirms the results of inspection. The apical beat is diffused and feeble or lost. When detectable it is found to be displaced upward and to the left. Altering the patient's posture changes the seat of the apex-beat (Oppolzer), and if the shock has been lost, turning the patient on his left side or bending his body forward may cause its return. The cardiac impulse disappears earlier when, on account of myocarditis, the systole is greatly enfeebled. On the other hand, old adhesions and marked hypertrophy of the heart may retain the apex-beat in contact with the chest wall despite the presence of a large accumulation. A friction-rub can be felt occasionally over the base of the heart even in the stage of effusion, and, if absorption takes place, the friction fremitus becomes more marked. Fluctuation is rarely detected. In large effusions the liver is *depressed and easily palpable*.

Percussion.—The area of cardiac dulness is increased, and assumes a characteristic triangular outline with the base downward and the apex extending up to the third or even second interspace to the left of, though near, the sternum. The lateral border-lines of dulness obviously diverge from above downward, the right passing to a point corresponding with the right edge of the sternum, along which it runs to the hepatic flatness; the other to the left, finally intersecting the base line, and extending to splenic flatness, or the lower limit of pulmonary resonance. Flatness may be met in the axillary region, even obliterating Traube's semilunar space. Rotch points out that even in moderate effusions there is flatness in the fifth interspace to the right of the sternum (*cardiohepatic triangle*—Ebstein). Broadbent, however, has found several instances in which dulness in this area was present, but at necropsy dilatation without effusion was found. Williamson,¹ in his careful and elaborate experimental and clinical studies of pericarditis with effusion, was unable

¹ *Arch. Int. Med.*, 1920, xxv, 206.

to demonstrate either of these two signs (Rotch's and Ebstein's) in a single case of small and medium-sized exudates. The margins of the lungs surrounding the heart may be retracted and the heart carried forward or dilated; the dull area will then appear larger than is justified by the amount of fluid. Retraction or moderate compression of the lung may give rise to a modified tympanitic resonance to the left of the flat area. Occasionally the lung is attached anteriorly, and the heart is crowded backward by the effusion, while the area of flatness on percussion is relatively diminished. The triangular shape of the flat area, noted when the patient is in the sitting posture, is lost and its area diminished when he lies down, the effusion obeying the laws of gravitation. Sibson's notch, or narrowness of the dull area at the third costal cartilage in the transverse diameter, with reflection of the dulness to the left below this level, thus forming an obtuse angle, obtains in medium-sized effusions. The feeble impulse can be at times felt within the dull area and not at its boundary. A very valuable sign, according to Williamson, is the pushing down of the left lobe of the liver.

Auscultation.—The characteristic friction-rub of the first stage has already been described. It may, however, also be audible over the base during the stage of effusion, and always returns, after absorption of the fluid, for a brief period. The heart sounds grow more and more distant, faint, and muffled, though the second sound, as heard over the extreme base of the organ, may remain clear. Over the area of dull tympany corresponding to the lower anterolateral portion of the left lung (which is more or less compressed) may be heard bronchovesicular breathing.

Course and Duration.—It will appear obvious that the course must vary in individual cases with the cause and severity of the infection. Observation has shown that in one class of cases the three stages are passed through in rapid succession, while in another class each stage is proportionately lengthened. The latter form has been termed "chronic" by some and "subacute" by others. The *acute* may be followed by the *chronic* variety. Usually serofibrinous effusions complicating rheumatism are absorbed with rapidity once the process has begun, seldom requiring more than two weeks. When recovery is about to occur, the temperature falls by *lysis*; the effusion is gradually absorbed, and with it the dyspnea disappears. Convalescence is further indicated by a return of the appetite, normal heat of the skin, and a more infrequent, full, and regular pulse. In cases that tend to a fatal termination either the fever continues or there is suddenly developed *hyperpyrexia*, as may happen when pericarditis occurs in the course of acute rheumatism; in such cases the dyspnea is urgent and cyanosis is often marked, with signs of failing circulation. *Nervous symptoms*, as extreme restlessness, insomnia, and active delirium, may be present. Under these circumstances death usually ensues at the end of a few days. In a fatal case of *acute articular rheumatism* that I saw, complicated by pericarditis, with hyperpyrexia, death occurred on the sixth day.

Complications.—Copious effusion may, by causing pressure upon the recurrent laryngeal nerve, produce paralysis of the vocal apparatus, or it may press upon the esophagus, causing dysphagia. Rarely *acute pleuritis* is a complication; it lengthens the course of the pericarditis and renders the outcome uncertain. When there coexists *extensive myocarditis* syncopal attacks often endanger the life of the patient. Associated endocarditis and a complicating pneumonia may be observed.

Prognosis.—In serofibrinous pericarditis recovery is the rule under favorable conditions. The outlook, however, becomes gloomy when the above-mentioned complications arise, and particularly when there is hyperpyrexia in connection with acute rheumatism. Occurring as a secondary event in serious acute diseases, as pneumonia, or in chronic diseases, as Bright's,

arise in the course of the acute infectious diseases belong to this category. The pneumococcus has been found in the pus (Shattuck and Porter). The membrane is much thickened and presents a gray, granular surface, and the myocardium underlying the visceral layer is softened, fragile, and pale looking (fatty).

Clinical History.—The local subjective symptoms and physical signs are the same in kind as in the former variety, but the amount of exudation is frequently less. At the onset *rigors* often occur, and may be repeated at varying intervals. The *temperature-curve* is of the suppurative type; the *pulse* is small, rapid, and irregular; and *physical prostration* is pronounced. Purulent pericarditis runs a comparatively rapid and an almost uniformly unfavorable course.

Diagnosis.—The chief clinical features are often referable to the primary or causal disease; hence in every instance in which purulent pericarditis is apt to arise a physical exploration of the chest is imperative. The purulent character of the effusion cannot readily be ascertained, as a rule; but the history of an affection having etiologic importance, the observance of rigors, a leukocytosis showing relative increase in the polynuclear forms, and the presence of the fever-curve peculiar to suppuration, would all point strongly to purulent effusion, and should lead to aspiration with the hypodermic needle—a harmless procedure if carefully performed, and one that almost constantly gives reliable results.

Treatment.—It is within the physician's province to treat the primary disease assiduously, but not pericardial empyema. Incision (after preliminary resection of a rib—Brentano) and drainage of the sac are advisable and feasible measures.

HEMORRHAGIC PERICARDITIS

In purulent pericarditis the effusion may be hemorrhagic, and particularly when it is of tuberculous origin. In non-purulent tuberculous pericarditis also the exudation is apt to be hemorrhagic. In the non-purulent instances that are due to chronic Bright's disease or that occur in the aged the effusion is sometimes blood-stained; and future observation may show that this variety is of more frequent occurrence than has hitherto been supposed. In ordinary serous pericarditis there is apt to be present more blood than in serous pleuritis. M. T. Ferrier has found 5 examples in 9 collections. Sears found a pure growth of pneumococci in the exudate from a case of hemorrhagic pericarditis. This etiologic variety scarcely calls for separate clinical consideration.

ADHESIVE PERICARDITIS

(Chronic Pericarditis)

Pathology and Etiology.—Chronic pericarditis follows the acute forms, and, as in the case of the latter, it may be partial or general. The effusion may rarely remain as a permanent condition, but not infrequently a clear history of the preceding acute attack is wanting. In most instances the opposed surfaces of the membrane are either universally or over a limited area firmly adherent. The amount of new connective tissue present or the degree of thickening of the layers varies greatly, and is dependent upon the type of the primary acute attack. If the latter is of mild grade—*e. g.*, the serofibrinous rheumatic form—not much thickening is encountered in the resulting chronic form.

Chronic tuberculous pericarditis is not uncommon, and is usually secondary. The disease may be chronic from the time of onset. The layers become enormously thickened, with obliteration of the sac.

In the dense exudate that remains after complete absorption of a pericardial effusion calcareous depositions occur, forming a bony casing, which either

partially or totally encircles the organ. The external surface of the pericardium may become united with adjacent tissues (spinal column, anterior thoracic wall, aorta, sinus pleuræ). The myocardium is the seat of atrophic and degenerative changes.

Etiology.—The principal etiologic factors are tuberculosis and rheumatism. Pilt analyzed 400 cases of acute pericarditis, of which 70 per cent. were due to rheumatism, about 50 or 60 per cent. died, and from 30 to 40 per cent. left the hospital with an adherent pericardium.

Symptoms.—Autopsies frequently discover an unsuspected adhesive pericarditis. Hypertrophic dilatation of the chambers usually develops sooner or later, and is due to adhesions that interfere with the free action of the organ as well as with its systole. When present the subjective symptoms point to a giving way of the right ventricle, as shown by the presence of venous stasis and dropsy. The pulse is rapid, of low tension, and irregular, and, though not diagnostic, the *pulsus paradoxus* is noted.

Pericarditis Callosa (Galvagni¹).—A form of chronic fibrous pericarditis which comes on insidiously during childhood and is exceedingly difficult of diagnosis (*vide infra*). Pericarditis callosa is characterized principally by facial cyanosis, slight edema, full and tortuous jugular veins without pulsation. The typical physical signs of pericarditis are wanting also. On the other hand, a congestive cirrhosis of the liver may supervene and lead to ascites.

Physical Signs.—*Inspection.*—Depression or pitting of the intercostal space, in place of the apex-beat, may be noticed. Synchronous with the systole there is also a retraction of the chest wall in the apical area, and less frequently over the whole precordia, the latter being an unerring sign of universal adhesions. The degree of systolic recession is slightly influenced by the respiration, inspiration increasing it, except adhesions exist between the pericardium and the adjoining pleura. It is best appreciated on palpation. When the apex-beat is not palpable, the systolic pitting over its site may be due to atmospheric pressure. During the diastole the heart forcibly rebounds, causing the so-called diastolic shock, which is of great diagnostic importance when associated with marked systolic retraction. Though not always visible, it can be readily felt on *palpation*. Friedreich's sign (the sudden collapse of the jugulars during diastole) may frequently be observed. Prior to the onset of dilatation the apex-beat may be forcible and visible over an increased area, indicating hypertrophy; but after the myocardium is weakened (from interference with its nutrition) and dilatation comes on, the impulse-beat is faint or wanting, and in marked systolic retraction may be vibratory. The fixed position of the apex-beat when the patient is turned upon his left side is a strong confirmatory sign.

Percussion.—The area of cardiac dulness is increased, especially upward and to the left, owing to the associated hypertrophy and pleuropericardial adhesions, and, since the latter do not allow the lungs to overlap the heart during inspiration, the upper and left lines of dulness remain fixed (C. J. B. Williams). The most trustworthy symptom is the unchanging shape of the area of precordial dulness during inspiration and expiration (Davis).

Auscultation.—In many cases no murmurs are detectable. Loud murmurs, quite independent of any value as regards cardiac lesions, however, may be audible; these may be due to the vortiginous movements in the endocardial blood-current occasioned by the jogging cardiac action. The murmur of tricuspid regurgitation, from a breakdown of the right ventricle without apparent exciting cause, is most significant.

¹ *Practitioner*, London, August, 1912.

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HEMOPERICARDIUM

By the term "hemopericardium" is meant hemorrhage into the pericardial pouch—a rare event. Among the causes are—(a) perforation by aneurysms of the aorta and the coronary arteries into the sac; (b) rupture of the heart due to injuries or cardiac aneurysms and fibrous formations from myocarditis; (c) direct injuries, especially stab and bullet wounds. The *symptoms* and *course* depend greatly upon the nature of the exciting cause. The most frequent factor, rupture of an aneurysm, proves quickly fatal from overcrowding of the heart. In rupture of the heart muscle there is sometimes a slow outpouring of blood, with a correspondingly slow course, varying from a few hours to a couple of days in duration. The physical signs of pericardial effusion come on with dyspnea and failing circulation, which lead to cardiac exhaustion and death. The blood-stained effusions occurring in certain forms of pericarditis (*vide supra*) are not to be regarded as instances of hemopericardium. Unconsciousness appears early, to be quickly relieved when the pressure is removed.

PNEUMOPERICARDIUM

(*Air in the Pericardium*)

In this complaint, besides air or gas, there is usually present pus, and less frequently blood; hence an appropriate term in most instances would be *pyopneumopericardium*. The *causes* are the following: (a) wounds; (b) a fistulous connection between the adjacent air-containing organs and the pericardium as the result of disease processes, such as pulmonary tuberculosis or empyema; (c) rarely decomposition of liquid pericardial effusions, or the development of gas-producing bacteria. The *symptoms* are equivocal. In the main they do not differ from those of pericarditis with effusion, excepting that dyspnea is more intense than in the latter affection. The physical signs, however, are different. In pneumopericardium there is tympanitic percussion-resonance over the precordia, though the fluid, when present, gives rise to a boundary-line of dulness. The change of the patient's posture decidedly alters the area of the tympanitic note. On auscultation may be heard loud, rasping friction-sounds having a metallic quality, intermingled with churning, splashing noises, or the so-called "water-wheel sounds." *Pneumothorax* when encysted in close proximity to the heart, displacing the latter organ, must be eliminated. The latter complaint gives cardiac dulness in an abnormal position and a metallic auscultatory sound synchronous with the respiratory movements—two diagnostic points of pneumothorax that are absent in pneumopericardium. The *prognosis* is grave, death coming on most commonly in a day or two. The admission of air alone might result in a spontaneous cure, as occurs rarely in pneumothorax. The *treatment* is the same as has been recommended for purulent pericarditis.

II. DISEASES OF THE HEART

ENDOCARDITIS

Definition.—Inflammation of the lining membrane of the heart. The process is usually confined to the valves, though the cardiac layer may also be affected.

Varieties.—(a) Simple acute endocarditis; (b) ulcerative endocarditis; (c) chronic endocarditis. The pathologic processes involved in the first two, the acute forms, are identical in nature, though they differ in severity. I have met with two instances that apparently occupied a middle ground.

SIMPLE ACUTE ENDOCARDITIS

(Endocarditis Verrucosa)

Pathology.—The disease is characterized by the formation of small vegetations on the segments, varying in size from excrescences that are scarcely visible to those the size of a pea. They are found chiefly on surfaces that are opposed to the blood-current, near the margin of the valve, and “forming a row of bead-like outgrowths.” Their seat corresponds to the point of maximum contact (Sibson), but the mitral valve is much more commonly affected than the aortic. With the segments the chordæ tendineæ are sometimes affected, and very rarely the latter are alone involved. The left side of the heart is much more frequently the seat of acute endocarditis than the right, except during fetal life, when the right side is almost exclusively involved. To account for the greater frequency of occurrence on the left side after birth it has been suggested that freshly oxygenated blood affords the most favorable condition for the multiplication of the micro-organisms principally concerned in the inflammatory process. Corroborating this view is the fact that during fetal life the blood in the right chamber is the more completely oxygenated. It has also been pointed out that before birth the right side, and after birth the left side, is the more active, and that the active side is apt to suffer on account of higher pressure. Obviously, the vegetations form an obstruction to the current of the circulation as it flows through the valvular opening. In the early stage the membrane in the vicinity of these excrescences shows a bright red color, which has usually disappeared in fatal cases before they come to autopsy. The *histologic changes* consist in a proliferation of the subendothelial tissue (small-celled infiltration), which forms the principal component part of the vegetation. On this basal mass of granulation tissue there is deposited fibrin from the blood, the latter being separable from the former in acute forms of the complaint. Micro-organisms have repeatedly been found in the fibrinous depositions, but the specific causal irritant has not as yet been discovered. Köster first advocated the view that endocarditis may begin as an embolic process, and Rosenow has shown that cocci may lodge in the capillaries of the valves, “the avascular structure of which serves to protect the cocci until they grow into clumps, around which fibrin is precipitated.” Intact valves have no capillaries, so Rosenow says that his experiments can best be understood in those cases in which old injury to the valves has led to their vascularization. In favorable cases either the vegetation is ultimately absorbed or there remains a small indurated mass. When the vegetations are of considerable size emboli may become detached by the force of the blood current, and be carried to the vessels of the extremities and to the various viscera, particularly the brain, spleen, and kidneys, giving rise to embolic infarcts. The latter event is frequently observed in cases in which acute endocarditis is engrafted upon chronic valvulitis.

Simple acute endocarditis may end in the more serious or ulcerative variety (*vide infra*). More commonly, however, does the simple form terminate in chronic valvulitis with deformity.

Etiology.—The most frequent cause of acute endocarditis is *acute articular rheumatism*, which induces the disease in not less than 40 per cent. of the cases. In young rheumatic subjects the liability to the complaint is particularly pro-

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are composed of granulation tissue, veiled by granular and fibrillated fibrin, containing numerous micro-organisms. At the base there is usually developed more or less reactionary inflammation. Osler, in an analysis of 209 cases examined by him with a view to ascertaining approximately the relative frequency with which the different parts of the heart were affected, obtained this result: Aortic and mitral valves together, 41; aortic valves alone, 53; mitral valves alone, 77; tricuspid in 19, pulmonary valves in 15, and the heart wall in 33 instances. In 9 instances the right heart alone was involved.

(b) *Malignant mural endocarditis* gives the same set of changes as the valvular form; indeed, the two may be combined throughout. It is a comparatively rare condition, as is shown by the foregoing figures of Osler. The ulcerative process may invade the chordæ tendinæ and the valves, and may perforate the septum or even the ventricular wall itself. The vegetations are detached in small or large masses, and are conveyed by the blood to various organs, especially to the spleen and kidneys, less frequently the intestines, meninges of the brain, and the skin. Their site is determined largely by their size, and they may be so large as to plug vessels of the caliber of the external iliac. When found in the lungs they may originate in endocarditis affecting the right heart. These emboli, containing as they do the agents of inflammation, form suppurative infarcts that may be either white or red in color. The detached vegetations are sometimes so laden with irritants as to cause rapid softening of the coats of the vessel at the point where they become arrested, with consequent aneurysmal dilatation directly opposite their seat. The number of infarcts varies greatly in different cases; thus there may be only one or two, as in a case in my own knowledge in which the spleen alone contained two small infarcts, or there may be more than a thousand minute abscesses widely scattered throughout the body.

Etiology.—It is to be kept in remembrance that the condition is, with few exceptions, most probably a secondary one. This explains why the lesions peculiar to simple acute endocarditis usually precede and accompany those of the ulcerative form.

Bacteriology.—The specific irritant is usually the *Streptococcus pyogenes* (Fränkel and Sängner); hence the diseases in which ulcerative endocarditis occurs as a complication merely furnish the opportunity for the invasion of the streptococcus. The *Bacillus diphtheriæ*, however, as well as the staphylococcus, meningococcus, the pneumococcus, the *Bacillus coli*, the *Bacillus anthracis*, the gonococcus, and other organisms, have been found in some cases in the absence of the streptococcus.

In purely septic diseases the cardiac element serves to facilitate the generation and rapid diffusion of the poison; and, since the latter is prone to attack the valve segments, the morbid lesions within the heart not rarely constitute the chief pathologic factor in septicopyemia.

Predisposing Affections.—The malignant form occurs, in connection with acute articular rheumatism, in about 10 per cent. of the cases in which acute endocarditis appears. In lobar pneumonia the ulcerative type is common, occurring almost as frequently as the simple variety, and was found by Osler in 11 out of 23 cases. The septic processes that arise from the puerperal state or from gonorrheal infection may also be complicated with ulcerative endocarditis. Among many other diseases that furnish occasional instances of this serious complication are measles, scarlet fever, typhoid fever, erysipelas, small-pox, chorea, tuberculosis, and chronic nephritis.

Clinical History.—That form of ulcerative endocarditis which is a more or less prominent factor in septic diseases has been considered in connection with septicemia. Malignant endocarditis being usually an intercurrent

endocarditis, as well as to its limited area of diffusion, and by the absence of the signs of hypertrophy and of marked accentuation of the second pulmonary sound.

A *relative insufficiency* distinguishes itself by a pure systolic murmur, loud and not invariably uniform, by a weak cardiac impulse, a slight accentuation of the second pulmonary sound, and a comparatively small and often irregular pulse. It is met with in excessive dilatation of the left ventricle, in anemia, "and particularly in certain changes of the valvular muscles due to myocarditis" (Leube).

Prognosis.—The immediate dangers are few, and depend largely upon the primary disease. In many instances, however, acute endocarditis initiates permanent lesions of the valves.

Treatment.—**Prophylaxis.**—The prevention of acute endocarditis in rheumatism has been dealt with in discussing the latter disease. No known direct measures can prevent the development of this condition in the course of the specific fevers, though absolute rest in bed and protection of the body against "cold" may diminish somewhat the tendency to it.

The Attack.—The sick-room should be free from drafts, though well ventilated, and flannel is to be applied to the chest. The diet may be liberal, but should be composed chiefly of milk and other light nutritious substances. Stimulants are required in most instances, and in abundance should the heart be failing. Digitalis is to be employed cautiously if at all. When the myocardium is involved, its use is not without danger; under these circumstances the drug increases the sufferings of the patient by throwing the inflamed and weakened cardiac muscle into firm contractions. I am convinced that in endocarditis due to acute articular rheumatism it is wise to continue the exhibition of the salicylates, though in moderate doses, provided that the heart is guarded by the use of stimulants. During convalescence from an acute endocarditis the patient should be kept at rest, so as to minimize the strain upon the affected valves and heart muscle; even after he has apparently recovered, and particularly should the murmur still be present, perfect quiet is to be enjoined for a period of several weeks.

ULCERATIVE ENDOCARDITIS

(*Malignant or Infectious Endocarditis*)

Malignant endocarditis is variously characterized, though usually either by perforative ulceration, by suppuration of the valves, or by both, giving rise to the physical signs of acute endocarditis. These develop amid the symptoms of a severe primary infectious or septic disease. There is at hand enough clinical evidence to warrant the assumption that ulcerative endocarditis also occurs, though rarely, as a primary affection.

Pathology.—(a) *Valvular Endocarditis.*—In its early development the valves are the seat of vegetations (such as are met with in simple acute endocarditis) which later undergo necrosis. The latter process tends to spread, destroying more or less of the endocardium. In the interior of the vegetations suppuration not infrequently takes place, and the abscesses thus formed rupture and produce various lesions according to their size and situation. After rupture the blood-current may enter the abscess cavity, and, if there be no complete perforation, the endocardium will be pouched out, and an aneurysmal dilatation of the valve will result. Ulcerative lesions are most frequently observed. They may be mere erosions of the endocardium, but, as a rule, are penetrating and often result in complete perforation. The vegetations take on a grayish- or yellowish-green appearance. Histologically, they

re composed of granulation tissue, veiled by granular and fibrillated fibrin, containing numerous micro-organisms. At the base there is usually developed more or less reactionary inflammation. Osler, in an analysis of 209 cases examined by him with a view to ascertaining approximately the relative frequency with which the different parts of the heart were affected, obtained this result: Aortic and mitral valves together, 41; aortic valves alone, 53; mitral valves alone, 77; tricuspid in 19, pulmonary valves in 15, and the heart wall in 33 instances. In 9 instances the right heart alone was involved.

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Clinical History.—That form of ulcerative endocarditis which is a more or less prominent factor in septic diseases has been considered in connection with septicemia. Malignant endocarditis being usually an intercurrent

left ventricle. The aortic ring to which the semilunar segments are normally attached becomes sclerosed, and finally the seat of atheromatous changes, either fatty or calcareous. Again, chronic inflammation of the intima of the aorta produces a similarly thickened condition of this layer in spots, followed by atheroma. These changes are most prone to take place in the course of the ascending arch of the aorta or just above the aortic segments. The diseased processes before described may extend to the coronary arteries. Hence sclerotic and atheromatous alterations in the blood-vessels are found frequently in association.

Much less commonly similar lesions are noted at the orifice of the pulmonary artery. A similar involvement of the auriculoventricular valves also causes regurgitant and obstructive deformities at the mitral orifice, and in advanced cases the chordæ tendineæ, and even the papillary muscles, are almost invariably invaded by direct extension from the valves. As these structures undergo marked thickening with subsequent contraction, they become shortened and rigid, causing an actual narrowing of the cardiac orifice. In mitral stenosis during the early stages a more or less complete ring of vegetations encircles the mitral orifice on its auricular aspect. The margins of the orifice also become hardened and roughened, with extension to the valvular curtains and the chordæ tendineæ. Under such circumstances the thickened valve could not, during the ventricular diastole, be forced back against the ventricular wall, but would occupy a nearly central position. Owing to cohesion of the free edges of the valvular structures and to contraction of the chordæ tendineæ drawing the leaflets toward the apex of the heart, the transition from this condition to the formation of a hollow cone (*funnel mitral*) is by natural, easy stages. Extensive union of the segments along their free margins may reduce the aperture to a mere button-hole slit (*button-hole mitral*) as viewed from the auricular aspect. The last two forms of lesions are far less commonly met with at the aortic orifice, though they occur rarely in moderate degree; on the other hand, curling of the valvular edges is far more commonly seen at the aortic than at the mitral orifice, if we except the cases that occur in children. The curtains of the thick, rigid valves may also permanently occupy the plane of the orifice, presenting a small ring-like opening (*annular mitral*).

Fatty degeneration leading to the formation of necrotic (atheromatous) ulcers is common; and calcareous deposits are frequently seen in old cases, either in localized areas or coextensive with the diseased tissue, converting the entire valve into a calcified mass, with loss of the valvular outlines.

Under such conditions of the valves the deposit of fibrin would be greatly favored, and the presence of an ulcerative surface on the valves affords a ready and satisfactory explanation of the occurrence of embolism in these cases. Emboli may also become detached from cardiac thrombi or from thrombi formed in the peripheral veins. For anatomic reasons the favored seats of embolic processes are, as in acute endocarditis, the spleen, brain, and kidneys, and irritants that cause acute endocarditis find here a tissue soil whose capacity for resistance to invasion is greatly lowered. *Chronic mural endocarditis*, which exhibits lesions in the form of grayish-white patches, and chronic myocarditis are, as a rule, due to the extension of the inflammation from the valves, though the ventricular endocardium may be invaded independently of the valvular affection. In one instance of mitral stenosis I observed an enormous calcareous mass partly in the subvalvular tissue and partly in the wall of the ventricle, the segments remaining altogether intact. In advanced stages of most cases of chronic endocarditis myocardial degeneration occurs. It takes the form of fibroid change or fatty degeneration, or both. Aortic valve involvement, especially when complicated with atheromatous change in the

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iters are ready to admit, and that it is favored especially by an occupation involving muscular strain (*e. g.* blacksmiths, draymen, soldiers during campaigns). Sex *per se* has little if any effect, though, owing to the greater frequency of certain well-known causes of valvular disease (chorea and rheumatism) in girls and young women, females may be more frequent sufferers than males.

AORTIC INCOMPETENCY

(*Aortic Insufficiency; Aortic Regurgitation*)

Definition.—The failure of the aortic valves to prevent a return flow of blood into the ventricle, owing, as a rule, to a diseased condition of the aortic leaflets (sclerosis) that is followed by crumpling and attended with contraction, shortening, or curling of the edges, and finally calcification.

Pathology.—Apart from the commoner lesions described above, the aortic orifice may be enlarged (relative insufficiency), and here the normal cusps fail to effect complete closure when they become tense. The cusps of the diseased aortic valves sometimes adhere to the intima of the aorta, and ulceration of the semilunar segments, which are the seat of disease processes (particularly ulceration), is sometimes found *postmortem*, and may be the chief factor in determining the development of the condition. This accident may, though rarely, occur as a result of a severe straining effort in the case of valves previously healthy. Occasionally, also, the principal factor in the production of this valvular lesion is a congenital malformation of the segments whereby they are rendered very prone to chronic endocarditis in consequence of the undue strain to which they are subjected. At times the lesions that give rise to stenosis may coexist with simple aortic incompetency. Aortitis is very frequently coexistent.

Mechanical Influence of the Lesion.—The reflux current passes from the aorta backward through the imperfectly closed semilunar valve into the left ventricle during the diastole of the heart or while the left ventricle is being filled by the normal blood-flow from the auricle. It is clear that overdistention of the left ventricle must result at once from two simultaneous influx currents of blood, with a tendency to an increasing dilatation, especially since the lesion itself is steadily progressive. To expel the increased amount of blood from the left ventricle demands increased cardiac power, and the over-exertion causes a compensatory *hypertrophy*. Dilatation and hypertrophy of the left ventricle develop *pari passu* until this chamber reaches enormous dimensions, forming the *cor bovinum*, which weighs 1000 grams or more (30 to 50 ounces). Under these circumstances the arterial system is overfilled at each ventricular systole. In the very early stage the reflux of blood from the aorta into the ventricle tends to lessen the volume of the circulating medium in the arterial tree, but this depleting influence is successfully counterbalanced by the augmented column of blood thrown from the ventricle during cardiac systole. Hence the requirements for bodily nutrition are, for a longer or shorter time, satisfied. The abnormally large amount of blood that is thrown into the arteries with undue force subjects them to increased tension, and as a result arteriosclerosis, leading sometimes to atheroma, is commonly developed, and presents its ulterior dangers (aneurysm, apoplexy). The coronary arteries are similarly involved, their caliber being reduced, and particularly at the point of origin. Soon or late the blood-supply to the heart muscle may become inadequate, and nutritional disturbances now manifest themselves in fatty and fibroid degeneration of the cardiac muscles; these pathologic changes

3) An acute endocarditis, in a few cases, may attack the aortic valves during the course of the septicemia. The secondary and late effects of this invasion may be shown by the production of chronic aortic valvular disease. Out of 100 recruits examined, 307 were examples of aortic regurgitation; 162 men had a history of rheumatic fever, while 1759 men had a history of rheumatic fever, but no aortic regurgitation.

(4) At times rupture of one of the leaflets of the valve may occur during sudden overstraining. It is likely, however, that such valves are previously weakened by some other process.

Relative insufficiency is caused in some instances by pronounced dilatation of the root of the aorta or by an aneurysm just beyond the aortic orifice. Incompetency of muscular origin, *e. g.*, marked dilatation of the left ventricle, occurs, though rarely. I have reported¹ 12 cases, of which 4 fell under personal observation.

Among the more effective predisposing factors are *age, sex, and race*. The disease occurs much more often in males than in females on account of the fact that a greater percentage of the former are engaged in occupations that predispose to the disease, and the greater incidence of syphilis in males. As to race, a preponderating proportion of the cases arise during advanced middle age. In the negro race the condition is twice as frequent as mitral disease.

Symptoms.—So long as the hypertrophy of the left ventricle successfully overcomes the otherwise injurious consequences of the valvular defect the harmonious balance of forces may be maintained, and then there is an almost entire absence of symptoms. I have observed, moreover, that compensation does not fail so early in young subjects as in those more advanced in years, and also when aortic incompetency is a sequel of atheroma combined with hypertrophy and dilatation of the left ventricle. With the development of marked hypertrophy severe muscular exertion and strong mental excitement will, by exciting overaction of the powerful heart, bring on a train of symptoms, as *throbbing headache, vertigo, and tinnitus aurium*. *Per contra*, the clinical manifestations of arterial *anemia*, particularly of the brain, and also those of general *arteriosclerosis*, frequently coexist. The patient's countenance exhibits *pallor*, and he complains of *headache, flashes of light* before the eyes, and *dizziness*. Dilatation of the peripheral vessels often leads to hot flushes and drenching sweats. Cases exhibiting the latter symptoms may be mistaken for *phthisis*. *Dizziness* is often distressing, and is more marked upon rising quickly from the recumbent to the erect posture. *Dyspnea* may come on early, but this rarely happens except upon inordinate exertion or great mental excitement—conditions that cause strong cardiac action and prohibit the discharge of blood from the left auricle into the left ventricle, thus causing *pulmonary congestion*. To some extent the cause of the dyspnea may be *acidosis*. Oppression in the precordial region and cardiac palpitation are commonly present, as is a *dull aching pain*, but it radiates not infrequently to the shoulders, and thence down the arms, particularly the left. Genuine *angina pectoris* may be a concomitant. I have seen instances of aortic regurgitation in which severe pain simulating rheumatism was located in the left shoulder-joint.

Following immediately upon **failure of compensation** the cardiopulmonary circulation is retarded, and there is increased *dyspnea*, the latter symptom being greatly intensified by undue exertion and at night. There may be *cough*, and not rarely *hemoptysis*, though less frequently than in simple mitral disease. Later on *general venous congestion* of a moderate grade follows pulmonary congestion, and the dyspnea now becomes severe. It is nocturnal, and often compels the patient to assume a semi-erect posture in bed. In the later stages

¹ *Johns Hopkins Hosp. Bull.*, July, 1909.

AORTIC STENOSIS

Definition.—A narrowing or stricture of the aortic orifice, due to thickening or adhesion of the valve segments, and causing an obstruction to the flow of blood into the aorta.

Simple aortic stenosis may be met with, though it is a great rarity. Its development is soon followed by more or less valvular incompetency. It may be secondary to aortic insufficiency; but this is rare, the latter lesion being unfavorable to the development of the former.

Special Etiology.—Rarely rheumatic endocarditis, and still less commonly other forms of acute endocarditis, cause union of the semilunar segments, with resulting stenosis. The most common causative factor is a *slow sclerosis of the aortic valve*, accompanied by calcareous deposits. The more or less immobile, rigid valves narrow the aortic orifice and oppose a barrier to the outflowing blood-current from the left ventricle. The aortic ring may be the seat of changes similar to those just described, resulting in a moderate grade of stenosis with intact leaflets. The lesions are most frequently to be regarded as a part of a general arterial sclerosis, most marked in the region of the thoracic aorta; sometimes, as Peter contends, they are distinctly secondary to sclerotic changes at the root of the aorta. The coronary arteries may be the seat of sclerotic changes. The condition is also rarely congenital. *Males* who have reached *advanced years* are especially prone to aortic stenosis, atheromatous processes belonging to that sex and period of life. Gallavardin has described a rare non-congenital and non-rheumatic form of aortic stenosis occurring in young subjects; it is characterized by extreme latency.

Mechanical Influence of Lesion.—To propel the normal volume of blood through the constricted aortic orifice requires increased strength on the part of the left ventricle, and, as a consequence, the latter hypertrophies. This hypertrophy develops slowly, is uncombined with extensive dilatation unless incompetency be associated, and keeps pace with the progress of the valvular lesions. The undue ventricular tension sometimes induces more or less sclerotic change in the mitral valves. Hypertrophy of the left ventricle eventually gives way to extreme dilatation, resulting in relative mitral incompetency, with its sequelæ, namely, pulmonary, followed by general venous, stasis.

The **symptoms** date from the commencement of failure of compensation often many years after the onset of the disease. Their appearance will be found to follow some unusual muscular effort or the operation of some depressing influence, as the too free use of tobacco or alcohol. They are due to disturbances of circulation arising from a gradual secondary dilatation of the left ventricle, which is now unable to propel the normal quantity of blood into the arterial tree. Hence *anemia*, especially of the brain and peripheral parts of the body, becomes pronounced, and is evidenced by such symptoms as *syncope*, *dizziness*, *headache*, and *pallor*. Since aortic incompetency usually manifests itself secondarily, the clinical features of both affections are sooner or later variously commingled. In cases in which mitral lesions develop they are overcome by compensatory enlargement of the right ventricle: the latter chamber may at a later period become dilated, in which event tricuspid regurgitation and the symptoms of general venous engorgement appear. *Slight edema* of the feet is common as a terminal symptom; marked dropsy, however, is uncommon. From the fibrous deposits on the segments, as well as from any small clots behind the valves, *emboli* are apt to become dislodged by the forcible blood-stream and be conveyed to the brain, spleen, kidneys, or other organs.

Physical Signs.—Inspection.—The apex-beat is gradually displaced downward and to the left, owing to left ventricular hypertrophy. It is, as a rule, slow, forceful, and heaving, but less frequently may be lacking in strength. It may be enfeebled, diminished in area, or absent, owing to associated emphysema. Absence of the apex-beat may be occasioned by diminished contraction of the myocardium, or during vigorous contraction of the heart, the ventricle emptying itself from the beginning, so that there is “no closing period and with it no apex-beat” (Leube).

Palpation discloses the forcible and heaving impulse-beat unless obscured or even absent owing to emphysema. A marked systolic thrill, with the seat of greatest intensity in the aortic region, is quite generally present. I have rarely felt this thrill in the apex region. The pulse-wave is small, regular, not compressible, and of normal or slightly lessened frequency (*sluggish*). The estimated blood-pressure is about normal.

Percussion.—Although hypertrophy of the left ventricle is present, the area of cardiac dulness is largely dependent upon the degree of emphysema associated. In the absence of this condition the dulness is increased to the left and downward, especially so when insufficiency coexists.

Auscultation.—A systolic murmur, harsh in quality, most audible at the aortic cartilage (the second right), and transmitted into the carotids, is present in typical aortic stenosis. When non-compensation is advanced the murmur is neither so rough nor so loud, and quite late it may be missing altogether. The second sound is faint or inaudible on account of the diminished blood tension in the aorta and the character of the valvular lesion. As aortic incompetency is commonly associated, a regurgitant or diastolic murmur is also heard, forming a *double* or *see-saw* murmur, the stenotic bruit more or less completely masking the regurgitant. A soft, blowing apical murmur (with the systole) is not infrequent after relative insufficiency of the mitral valves has appeared.

The diagnosis demands the concurrence of the following signs: a systolic thrill, most marked at the base; a tense, small, somewhat slow pulse; indications of left ventricle hypertrophy (unless emphysema be present); a rough, loud, systolic murmur at the aortic cartilage, propagated into the vessels of the neck, and a feeble second aortic sound.

Differential Diagnosis.—A calcareous plate lying on the intima of the aorta and a markedly roughened condition of the aortic segments are conditions frequently mistaken for aortic stenosis, since they give rise to a murmur possessing many of the characteristics of the one above described. These murmurs, however, are seldom musical, while the murmur of aortic stenosis is often so; moreover, the second sound is decidedly accentuated, while in aortic stenosis it is faint. In *chronic Bright's disease* with arterial sclerosis and left ventricular hypertrophy a murmur of maximum intensity may be developed at the base; but here the urinary symptoms, together with intensification of the second sound, are sufficient for a discrimination. In *aortic regurgitation* a systolic murmur frequently coexists, but it cannot be reckoned as indicating actual stenosis unless it has a musical quality and a systolic thrill can be felt on palpation. In combined aortic regurgitation the characteristic condition of the pulse of stenosis may be missing. The basic murmurs of *chlorosis* and other forms of anemia are soft, distant, not transmitted, and not harsh; the intense thrill and ventricular hypertrophy are absent. The venous hum may also be heard in the veins of the neck. *Pulmonary stenosis* occurs in young subjects, and while it gives rise to a harsh systolic murmur, is best heard to the left of the sternum, is propagated upward and to the left, and the second pulmonic sound is weak.

AORTIC STENOSIS

Definition.—A narrowing or stricture of the aortic orifice, due to thickening or adhesion of the valve segments, and causing an obstruction to the flow of blood into the aorta.

Simple aortic stenosis may be met with, though it is a great rarity. Its development is soon followed by more or less valvular incompetency. It may be secondary to aortic insufficiency; but this is rare, the latter lesion being unfavorable to the development of the former.

Special Etiology.—Rarely rheumatic endocarditis, and still less commonly other forms of acute endocarditis, cause union of the semilunar segments, with resulting stenosis. The most common causative factor is a *slow sclerosis of the aortic valve*, accompanied by calcareous deposits. The more or less immobile, rigid valves narrow the aortic orifice and oppose a barrier to the outflowing blood-current from the left ventricle. The aortic ring may be the seat of changes similar to those just described, resulting in a moderate grade of stenosis with intact leaflets. The lesions are most frequently to be regarded as a part of a general arterial sclerosis, most marked in the region of the thoracic aorta; sometimes, as Peter contends, they are distinctly secondary to sclerotic changes at the root of the aorta. The coronary arteries may be the seat of sclerotic changes. The condition is also rarely congenital. *Males* who have reached *advanced years* are especially prone to aortic stenosis, atheromatous processes belonging to that sex and period of life. Gallavardin has described a rare non-congenital and non-rheumatic form of aortic stenosis occurring in young subjects; it is characterized by extreme latency.

Mechanical Influence of Lesion.—To propel the normal volume of blood through the constricted aortic orifice requires increased strength on the part of the left ventricle, and, as a consequence, the latter hypertrophies. This hypertrophy develops slowly, is uncombined with extensive dilatation unless incompetency be associated, and keeps pace with the progress of the valvular lesions. The undue ventricular tension sometimes induces more or less sclerotic change in the mitral valves. Hypertrophy of the left ventricle eventually gives way to extreme dilatation, resulting in relative mitral incompetency, with its sequelæ, namely, pulmonary, followed by general venous, stasis.

The **symptoms** date from the commencement of failure of compensation often many years after the onset of the disease. Their appearance will be found to follow some unusual muscular effort or the operation of some depressing influence, as the too free use of tobacco or alcohol. They are due to disturbances of circulation arising from a gradual secondary dilatation of the left ventricle, which is now unable to propel the normal quantity of blood into the arterial tree. Hence *anemia*, especially of the brain and peripheral parts of the body, becomes pronounced, and is evidenced by such symptoms as *syncope*, *dizziness*, *headache*, and *pallor*. Since aortic incompetency usually manifests itself secondarily, the clinical features of both affections are sooner or later variously commingled. In cases in which mitral lesions develop they are overcome by compensatory enlargement of the right ventricle: the latter chamber may at a later period become dilated, in which event tricuspid regurgitation and the symptoms of general venous engorgement appear. *Slight edema* of the feet is common as a terminal symptom; marked dropsy, however, is uncommon. From the fibrous deposits on the segments, as well as from any small clots behind the valves, *emboli* are apt to become dislodged by the forcible blood-stream and be conveyed to the brain, spleen, kidneys, or other organs.

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Percussion.—Although hypertrophy of the left ventricle is present, the area of cardiac dulness is largely dependent upon the degree of emphysema associated. In the absence of this condition the dulness is increased to the left and downward, especially so when insufficiency coexists.

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The diagnosis demands the concurrence of the following signs: a systolic thrill, most marked at the base; a tense, small, somewhat slow pulse; indications of left ventricle hypertrophy (unless emphysema be present); a rough, loud, systolic murmur at the aortic cartilage, propagated into the vessels of the neck, and a feeble second aortic sound.

Differential Diagnosis.—A calcareous plate lying on the intima of the aorta and a markedly roughened condition of the aortic segments are conditions frequently mistaken for aortic stenosis, since they give rise to a murmur possessing many of the characteristics of the one above described. These murmurs, however, are seldom musical, while the murmur of aortic stenosis is often so; moreover, the second sound is decidedly accentuated, while in aortic stenosis it is faint. In *chronic Bright's disease* with arterial sclerosis and left ventricular hypertrophy a murmur of maximum intensity may be developed at the base; but here the urinary symptoms, together with intensification of the second sound, are sufficient for a discrimination. In *aortic regurgitation* a systolic murmur frequently coexists, but it cannot be reckoned as indicating actual stenosis unless it has a musical quality and a systolic thrill can be felt on palpation. In combined aortic regurgitation the characteristic condition of the pulse of stenosis may be missing. The basic murmurs of *chlorosis* and other forms of anemia are soft, distant, not transmitted, and not harsh; the intense thrill and ventricular hypertrophy are absent. The venous hum may also be heard in the veins of the neck. *Pulmonary stenosis* occurs in young subjects, and while it gives rise to a harsh systolic murmur, is best heard to the left of the sternum, is propagated upward and to the left, and the second pulmonic sound is weak.

hypertrophy. As soon as this harmonious balance is disturbed, either as the result of increase in the degree of incompetency or of failure of muscular power, the progress of the blood from the right auricle to the right ventricle is hindered. Increased pressure in the right auricle produces dilatation of its chamber, with subsequent general venous congestion as a natural backward effect (*vide Tricuspid Regurgitation*). It is now seen that when the right heart fails a lessened amount of blood reaches the left ventricle, and hence an abnormally small amount finds its way into the aorta; this fact explains the presence of the low arterial tension late in the disease. Hypertrophy of the left ventricle in this disease has also been attributed in part to the augmented tension in the general capillary vessels that is occasioned by the venous stasis.

Special Etiology.—(a) *Rheumatic endocarditis* is the most frequent cause, though mitral regurgitation also results less frequently from acute endocarditis due to other causes. (b) It may be a part of a *general arteriosclerotic process*, caused, not rarely, by syphilis and alcohol. (c) A *diseased condition of the columnæ tendineæ*, if it contracts them or weakens their structures so that the free edges of the segments pass beyond the plane of the orifice, produces insufficiency. (d) It rarely arises in the course of *aortic valvular disease* (a secondary mitral affection), and is then excited mainly by undue tension of the blood in the left ventricle. Here the lesion is of a mild grade, as a rule. (e) It is frequently occasioned by *enlargement of the left auriculoventricular ring* (relative incompetency), resulting from excessive dilatation of the left ventricle, as in aortic incompetency, aortic stenosis, long-continued fevers (toxic myocarditis), and the graver anemias. (f) *Ulcerative endocarditis*, either by perforating or producing rupture of the valve-curtains or by destroying the chordæ tendineæ, may bring about mitral incompetency. Among *predisposing factors* age and sex are worthy of special mention, the incompetency occurring with greatest relative frequency in young adults (from twenty to thirty years of age, according to Ashton's figures) and somewhat more commonly in males.

Symptoms.—*During Compensation.*—In healthy persons the compensatory forces keep pace with the valvular lesions for an indefinite and usually lengthy period, during which time there may be an entire absence of symptoms. When present they are dependent upon disturbances of the cardiopulmonary circulation that are occasioned by trivial causes, such as excitement, going up stairs, or other forms of active physical exertion. Under these circumstances the force of the regurgitant current is increased (by the hypertrophied left ventricle), thus producing more or less *pulmonary congestion* that may proceed to edema of the lungs or hemoptysis. The condition is usually a temporary one, and is attended by *dyspnea*, *palpitation of the heart*, a *short, hacking cough*, and *expectoration* of a frothy serum that may be blood-stained. The relation existing between the severity of the dyspnea and the degree of active physical exertion is positive and vital. Shortness of breath may be the sole feature during a long period. The rational symptoms rarely warrant a suspicion of the existence of mitral disease until compensation has failed, but the patient's appearance often indicates heart disease. The *face* is pale and the features peaked, the eyes, lips, and ears are dusky, and the minute vessels of the cheeks are prominent. Clubbing of the finger-nails is observed most frequently in the young.

After Failure of Compensation.—Failure of compensation implies failure of the right ventricle to cope efficiently with the augmented tension in the pulmonary circulation, with accompanying congestion of the lungs, followed by engorgement of the systemic veins. The latter process begins at the right heart and proceeds toward the periphery, involving the viscera, mucous membranes, and extremities until it is universal. The *pulmonic symptoms* above detailed are now more marked, particularly the dyspnea (which may be con-

the pulmonary vessels engendered by the hypertrophy of the right ventricle. ~~combined~~ murmurs may be heard, and not infrequently a rough, rolling, or ~~trailing~~ presystolic murmur is detected. A frequent late occurrence is secondary dilatation of the right ventricle, causing relative tricuspid insufficiency with its characteristic soft, low-pitched, systolic murmur, heard best at the ~~uniform~~ cartilage. A spurious diastolic murmur may be noted, though rarely, ~~then~~ the sounds are timed with the pulse. This is due to a weak systole that fails to cause a radial pulse.

Diagnosis.—In the presence of the following group of features the diagnosis is set at rest: A marked broadening of the area of cardiac dulness; a

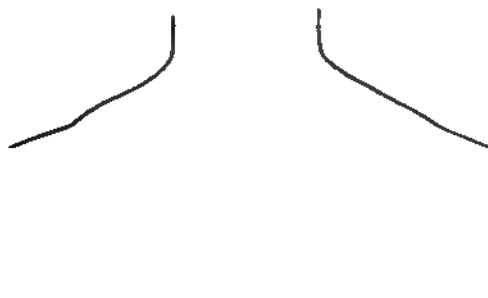


Fig. 49.—1, Seat of greatest intensity; 2, direction of chief transmission; 3, boundary-line of relative dulness; 4, boundary-line of absolute dulness (modified from Sahli).

systolic, apical murmur that is conveyed to the left axilla and may be heard even at the back; and a decided accentuation of the pulmonary second sound. Obviously, the latter sound becomes feeble after dilatation of the right ventricle has occurred. A systolic thrill is of the highest diagnostic importance, but is unfortunately absent in perhaps a majority of the cases. Free regurgitation through the mitral orifice may be safely inferred when the following signs are concurrent: (a) An absence of the sound of mitral-valve tension, a murmur replacing the first sound; (b) accentuation of the pulmonic second sound; (c) an enlarged area of the left cavity; (d) an enlarged area of the right cavity (Sansom). Conner¹ shows that, as a result of the extensive examinations made of recruits to the United States Armies during the war, mitral insufficiency should not be diagnosed upon the single finding of an apical systolic murmur.

Differential Diagnosis.—There are two organic lesions of the heart that are sometimes mistaken for mitral incompetency, since both are accompanied by a systolic murmur—the one aortic stenosis, and the other tricuspid regurgita-

¹ *Amer. Jour. Med. Sci.*, 1919, clviii, 773.

tion. How to distinguish mitral from tricuspid incompetency is a question that will receive due attention when the latter disease is considered. *Aortic stenosis* generates a systolic murmur, but it is loudest over the base, and is transmitted through the great vessels of the neck; while the mitral systolic is most intense over the apex and is transmitted far to the left. In mitral incompetency the pulmonary second sound is accentuated; in aortic stenosis it is not. In mitral insufficiency both ventricles are enlarged, as shown by percussion and other signs; in aortic stenosis the hypertrophy affects chiefly the left ventricle. In mitral incompetency a thrill, most marked over the apex-beat, may be felt; in aortic stenosis a thrill, rough and having its chief seat at the base, is present. Additional points of distinction are furnished by the contrasting factors of the pulse, the age of the patient, and other etiologic influences. *Cardiopulmonary murmurs* may simulate the murmur of mitral insufficiency, but can be readily differentiated, as they disappear when the patient holds the breath.

Functional systolic murmurs are often confounded with mitral insufficiency. The considerations on which the greatest dependence is to be placed in the differentiation are given in the subjoined parallel tables:

MITRAL INCOMPETENCY	FUNCTIONAL AND HARMLESS MURMURS
<i>History</i>	
Previous history of rheumatism or other disease causally related.	History of one or other form of anemia, of debility, or of Graves' disease, in many cases. Found in 13 per cent. of soldiers, about to be discharged, when in recumbent position (King ¹).
Frequently there is definite knowledge of rheumatism and organic heart disease, in combination in the same individual.	No such association.
<i>Physical Signs</i>	
<i>Inspection.</i> —Dusky lips, ears, etc.; later wavy pulsation in veins of neck.	Pallor of skin and mucous surfaces common.
<i>Palpation.</i> —Finger-tips placed over apex-beat forcibly lifted. Pulse-tension somewhat lowered and not prolonged. Impulse displaced.	Finger not lifted by the impulse, which often cannot be felt. Impulse not displaced.
<i>Percussion.</i> —Evidence of dilatation of both ventricles.	No change in percussion outline of the heart.
<i>Auscultation.</i> —A systolic apex-murmur (often musical), with characteristic area of transmission. This murmur is often heard posteriorly; pulmonary sound accentuated. Murmur does not disappear when patient is in upright position.	Soft systolic murmur at apex (variable in intensity, rarely transmitted to axilla), usually preceded by or associated with a basic systolic murmur and a venous hum in the veins of the neck. Murmur usually disappears or becomes much weaker in changing from recumbent to upright position. Tachycardia common.

To differentiate *relative* from *organic mitral incompetency* is difficult. It rests upon two points: (a) the character of the murmur, which is softer and shows greater changes in intensity (*e. g.*, being either less pronounced or disappearing if the heart is "whipped up" by digitalis) than that due to valvular lesions; and (b) the antecedent history of the patient. Thus, relative insufficiency of the mitral segments probably exists in patients in the middle period of life, in whom the previous history either furnishes such etiologic factors as chronic gout, syphilis (the latter, however, may also cause chronic valvulitis), or evidences of myocarditis, fatty heart, or anemic conditions; or in persons

¹ *Arch. Int. Med.*, 1919, xxiv, 89.

to exhibit arteriosclerosis or organic disease of the aortic valve and an apical systolic murmur. Again, if persistent in chronic *renal* disease, with concurrent symptoms of high arterial tension and of left ventricular hypertrophy—accentuation of the second aortic sound, a mitral systolic murmur—it is to be ascribed to relative insufficiency. On the other hand, if the signs of mitral regurgitation occur in a younger subject or in one who has been afflicted with acute rheumatism, it is highly probable that the mitral-valve segments are the seat of chronic endocarditis of rheumatic origin. *Compression of the apex of the left lung* by the ventricular systole may produce a spurious murmur. A rare sequel of mitral incompetency is mitral stenosis, owing to the contraction of the mitral orifice.

MITRAL STENOSIS

Definition.—Constriction of the left auriculoventricular orifice due to either thickening or cohesion of the segments. In most cases adhesions of the free borders of the valve or of the chordæ tendineæ obtain. Mitral stenosis is generally followed by insufficiency, and it is also frequently associated with adhesive pericarditis.

Special Pathology and Etiology.—It is to be recollected that the constriction may be almost inappreciable, and yet an uneven, roughened surface be presented, producing a murmur. A high degree of constriction, however, “which is more frequent than is generally supposed” (Elliott), may be encountered. Thus, in the *funnel-shaped* form of mitral stenosis the aperture may be so small as scarcely to admit the passage of a goose-quill. When moderate in degree the tip of the index-finger is admissible; in the *button-hole* form the slit may be so narrow as not to allow an object larger than a shirt-button to pass through it. This form is comparatively rare in children, while the *funnel* variety is common, and is occasionally a congenital condition (possibly hereditary). In adults, however, the funnel-shaped constriction is rare, while the button-hole valve is common; in 62 *postmortem* examinations only 3 showed funnel-form contraction (Hayden and Fagge). Mitral stenosis is, generally, dependent upon a mild or limited endocarditis of rheumatic origin. It is more common in *young adults* and in *children* after the fifth year than in older persons, and a greater incidence is shown in *females*, for the reason that the affections that are causally related to endocarditis are more frequent in females (rheumatism, chorea, tonsillitis). The endocarditis of measles and scarlatina may also lead to narrowing of the mitral orifice, and I quite agree with Osler in the belief that whooping-cough, owing to the great strain that it imposes upon the heart-valves, may be accountable for certain cases. In adults *arteriosclerosis* and *chronic nephritis* may act as causes. The hemorrhagic cases may at times be the immediate effect of an accident.¹ In not a few cases the etiology is obscure, particularly in adult women. Ball-thrombi have been found in the auricle.

Mechanical Influence of the Lesion.—The task of the left auricle is greater than normal, and as a consequence its walls hypertrophy. They may be found to be $\frac{1}{4}$ or even $\frac{1}{2}$ inch (0.6 or 1.2 cm.) in thickness, the normal thickness being only $\frac{3}{8}$ inch (3.7 mm.). Dilatation of the auricle comes on early, since this chamber cannot take on much hypertrophy owing to lack of muscular structure, and in the later stages its walls become extremely

the sixth left costal cartilages and the lower half of the sternum is observed, particularly in children. After failure of compensation the impulse is feeble and undulating, with engorgement and pulsation of the jugular veins.

Palpation discovers a presystolic thrill in a great proportion of cases. In certain instances active physical exertion may render this appreciable, or when in the recumbent posture on the left side the elevation of the arms may accomplish the same result. It is, however, absent in rare instances before failure of compensation occurs, and more frequently by far the latter event. The thrill usually disappears with the onset of fibrillation of the auricles, though in rare cases it may persist. The systolic shock remains. This fremitus is best felt over the third and fourth (less frequently the fifth) interspaces, just within the nipple, and during expiration. It commences after the second sound (during the diastole) as a purring fremitus, increasing steadily in volume and intensity, and terminates abruptly with the severe shock of the new impulse. The fremitus and systolic shock may be relied upon in the absence of the murmur when considered in conjunction with the history of a previous attack of acute rheumatic fever. They are not, however, pathognomonic, as "a presystolic thrill best felt in the erect posture, when the heart is accelerated through emotion or exercise, associated with a reduplication of the first sound and a more or less marked systolic shock at the apex, becoming less perceptible or disappearing when the patient is in the recumbent position—is a normal phenomenon in a certain proportion of healthy adults" (Morris and Friedländer¹). The heart's impulse is most forcible over the lower portion of the sternum and along the right border, being due to the enlarged right ventricle; in a smaller proportion of cases, in the third, fourth, and fifth interspaces to the left of the sternum. The radial pulse is small and compressible. An arrhythmia of time, force, and volume is frequently present and is due to auricular fibrillation (*q. v.*).

Percussion shows an extension of heart dulness to the right, frequently 5 cm. (2 inches) beyond the sternal margin, as a result of hypertrophy of the right ventricle, and upward as high as the second rib on either side of the sternum. Increase in the cardiac dulness to the left also occurs not infrequently, and is attributable to excessive enlargement of the right ventricle, though more often of the left ventricle in consequence of associated mitral insufficiency.

Auscultation reveals a rough, presystolic murmur, which may be characterized as churning or rolling, acquiring increased intensity (*crescendo*). It occurs synchronously with the thrill. Its point of greatest pronounciation is just above and about 1 inch within the normal apex-beat. The area of transmission does not exceed a couple of inches in any direction. Griffith, however, has shown that the murmur may be widely transmitted. This murmur sometimes exhibits atypical characters: it may be brief, low-toned, and inconstant. The best conditions for hearing the murmur are with the patient in the left lateral position, after exercise (Pardee²). After auricular fibrillation makes its appearance the murmur may absent itself either temporarily or permanently. Lewis says that no murmur precedes the first heart sound when the rest of diastole is free from murmurs.³ Diastolic murmurs are, however, frequent when the auricle contraction is absent; they vary much in character according to the length of diastole, which in auricular fibrillation varies much from beat to beat. The so-called Graham-Steel murmur (diastolic) along the left border of the sternum was heard in 37.5 per cent. of 24 cases

¹ *Jour. Amer. Med. Assoc.*, 1918, lxi, 376.

² *Amer. Jour. Med. Sci.*, 1919, clviii, 319.

³ Wiggers, *Circulation in Health and Disease*, Phila., 1915, p. 321.

also usually be found where a continuous bruit, covering a portion of the period of diastole and the systole, is audible. A rumbling apical sound resembling a presystolic murmur may be heard in pericardial adhesion. Its seat is different and it does not end in sharp systolic shock.

In *aortic regurgitation* the presence of a presystolic thrill and murmur has rarely been recorded, and Fisher, Phear, and others have noted them in simple dilatation ("relative mitral stenosis"). When a purely diastolic murmur is present in the aortic area, indicating aortic regurgitation, the diagnosis of mitral stenosis must be made with due caution.

TRICUSPID INCOMPETENCY

(*Tricuspid Regurgitation*)

Definition.—An imperfect closure of the tricuspid valve, due either to a dilatation of the right ventricle that is secondary to mitral or lung disease, or, less frequently, to an inflammatory shortening of the valves.

Pathology and Etiology.—As a primary disease tricuspid incompetency is rare. It, however, is not uncommonly due to chronic organic changes, though originating in fetal endocarditis. After birth this variety is most common during childhood, and the frequency of occurrence is in inverse ratio to the age. At any period of life, however, chronic affections of the lungs or organic disease of the left side of the heart may, by augmenting the tension in the right ventricle, produce chronic interstitial changes in the tricuspid segments. These are usually of mild grade. In chronic bronchitis associated with emphysema, and in pulmonary tuberculosis, extensive lesions of these valves are seen rarely, owing to the fact that dilatation of the right ventricle is soon followed by relative insufficiency, and thus the strain is in great part removed from the valves themselves. And yet, according to Byron Bramwell, the tricuspid valve is implicated in 50 per cent. of all cases of acute endocarditis. He suggests that the acute form frequently results in cure because of the relatively diminished right intraventricular tension. In rare instances one of the leaflets has been ruptured by straining. The relative tricuspid insufficiency, produced in a manner analogous to relative mitral insufficiency, is an exceedingly common secondary condition in affections of the lungs and heart that cause hypertrophy and dilatation of the right ventricle (mitral incompetency and stenosis, pulmonary carcinoma, emphysema, pulmonary tuberculosis, sclerosis of the lung).

Physiologic Pathology.—In tricuspid leakage every systole of the right ventricle is accompanied by a reflux of venous blood through the imperfectly closed tricuspid orifice into the auricle, and thence into the veins. This causes venous stasis and visible pulsation, and in this manner the engorged pulmonary circulation is somewhat relieved. An unfavorable consequence, however, of the reflux current from the right ventricle is the lessened blood-supply to the already engorged pulmonary arteries. The hypertrophied and dilated right heart now undergoes further enlargement in the same manner as in the hypertrophy of the left ventricle following mitral incompetency, though to a less extent. In mitral incompetency the right ventricle compensates the mitral lesion after failure of the left auricle, but there can be no such effective compensatory mechanism after failure of the right auricle in tricuspid incompetency, since the right heart is not reinforced by a fellow as is the left. The blood-stream flowing into the right ventricle during diastole, however, is abnormally large, owing to moderately increased venous tension. When the right ventricle

Percussion.—The extent and form of precordial dulness are variable according to the nature of the causative disease, but a dulness extending far beyond the right edge of the sternum is especially characteristic.

Auscultation.—A systolic murmur having its seat of greatest intensity at the base of the ensiform cartilage (Fig. 50) is almost constantly audible. The area in which it is best heard varies according to the intensity of the murmur. Lowering the patient's head, while in the recumbent posture, causes murmurs to become evident which were not previously heard (Stern's sign). It is clearly conveyed to the left 1 inch beyond the left sternal margin, and to the right and upward for an equal distance beyond the limit of cardiac dulness. It is soft in character, short, and often faint. If the heart be weak, it may be absent. Additional murmurs, due to primary lesions, are often



Fig. 50.—1, Seat of greatest pronunciation; 2, chief direction of conveyance; 3, boundary-line of absolute dulness; 4, boundary-line of relative dulness (modified from Sahli).

heard, and usually at other orifices. The second pulmonic sound is not much accentuated.

Diagnosis.—I believe that the most valuable symptom for diagnosis is the venous pulse, whether observed clearly in the neck or determined positively by bimanual palpation of the liver. Neumann holds that a slight venous pulse, visible only on retracting the head, excludes tricuspid insufficiency. The murmur is generally audible. Relative-incompetence distinguishes itself from that due to valvulitis by greater extension of dulness to the right, and by disappearance of the positive venous pulse and murmur, with restoration of compensation. The differential diagnosis between mitral and tricuspid regurgitation is easy when either exists alone, if it be remembered that the seat of greatest pronunciation, the area of transmission, and the acoustic character of the respective murmurs are widely different. But it is extremely difficult to dis-

of the lesion is to cause hypertrophy and dilatation of the right ventricle. Cases have been reported by Allyn, Gibson, and others. The pulmonary symptoms, with cyanosis, are marked. The *physical signs* furnish no diagnostic characteristics. There is developed a diastolic murmur which is most audible in the second left interspace, and is transmitted to the lower sternal region, simulating the murmur of aortic regurgitation. The water-hammer pulse and marked hypertrophic dilatation of the left ventricle are present in the latter complaint, however, and are absent in pulmonary regurgitation. In pulmonary insufficiency, on the other hand, hypertrophy and dilatation of the right ventricle ensue. Preble reports a case of *relative insufficiency* of the pulmonary cusps (the so-called Graham Steele murmur); at the autopsy aortic and mitral insufficiency were also found.

PULMONARY STENOSIS

A quite frequent form of *congenital malformation* of the heart is the narrowing of the pulmonary orifice. In the rarest cases it is of *postnatal* date, and may result in induration, contraction, and fusion of the segments. In one of Osler's cases the orifice "was only 2 mm. in diameter, with vegetations of acute endocarditis on the segments." I saw one case in which the pulmonary artery near the valve was contracted to one-half its normal caliber. *Myocarditis* with resulting contraction of the conus arteriosus may cause pulmonary stenosis, and some of the cases that originate during adolescence and later in life are due to *atheromatous* change, while others possibly are the result of *chronic endocarditis*, direct *violence*, and *ulcerative endocarditis*. The lesion is compensated by a hypertrophy of the right ventricle, following which dilatation and tricuspid incompetency may appear.

Symptoms.—*Cyanosis* and *distention of the systemic veins* and, later, *dropsy* are observed.

Physical Signs.—A systolic *thrill* may be felt at times over the base. There is considerable enlargement of the right ventricle, as elicited by *percussion* and *palpation*, and a *systolic murmur* is audible, its greatest distinctness being, as a rule, in the third left space near the sternum. It is *harsh*, superficial, and transmitted a short distance upward and to the left. Occasionally this murmur is heard best at the aortic valve, but it is never conveyed to the vessels of the neck, and hence is easily distinguished from the aortic systolic murmur. Its harsh character and loudness would serve to obviate confusion with *functional* or *anemic murmurs* that are sometimes heard here. The pulmonic second sound is weak, and, not rarely, there is a diastolic murmur of the same character, indicating *pulmonary regurgitation*. Broadbent asserts that a *temporary* systolic murmur due to severe exertion may be observed, and I have noted a systolic murmur in the pulmonary area in young adults of remarkably vigorous build and unusual endurance. This accidental systolic basal murmur is extremely common. Indeed, during the course of the cardiovascular examinations of the recruits in the Great War statistics were compiled which show that it is present in from 15 to 25 per cent. of normal healthy soldiers who present no sign of cardiac disease. A careful review of the literature indicates that stenosis of the pulmonary artery predisposes to lung tuberculosis. The conditions are not favorable to healthy nutritive processes, especially of the lungs (Anders).

Acute endocarditis (including the ulcerative form); (2) acute pericarditis; (3) pleurisy; (4) pneumonia; (5) nephritis, followed by uremia; (6) local or general arterial sclerosis; (7) chronic gastric or intestinal catarrh with intercurrent acute attacks; (8) embolic processes; (9) angina pectoris; (10) edema of the lungs; (11) hysteria, neurasthenia, epilepsy, and insanity; (12) rupture of the skin of the extremities in consequence of excessive edema, with erysipelatous inflammation; (13) febrile paroxysms, accompanied not rarely by syncope, occur at varying intervals of time, and are due to various causes, as rheumatism, simple, acute, and ulcerative endocarditis, and pericarditis.

Course and Duration.—When valvular disease consists in rupture of a segment the course is brief and usually proves quickly fatal. Apart from these exceptional instances the duration is measured by months, or more often by years or even decades. Statements applicable to all cases cannot be made, however, owing to the wide differences in different cases. Among the circumstances affecting the duration I would mention in particular the patient's mode of life, the hygienic conditions under which he lives, his occupation, mental condition, and the severity of the morbid processes. Every experienced physician has doubtless met with a small class of cases that have terminated fatally in from six months to a year, having developed in that period all of the serious phenomena and complications of the more chronic forms of organic heart disease. In the preponderating proportion of cases, however, the course is exceedingly slow, and often cases have existed many years before they have finally been recognized. In numerous instances the patient follows his usual vocation, which may even be laborious, for years, and without discomfort. In other cases the symptoms, as dyspnea on exertion, are so slight as not to excite suspicion. Facts such as these render it obvious that while the period of compensation is long, its exact limits are indeterminable.

The *progress after failure of compensation* is more definitely known, since frequent opportunities for observation are afforded. At this time the cases also exhibit wide differences in duration; in my own experience they have varied from two or three months to as many years (rarely even longer), depending much on the patient's mode of living. The course may be shortened by severe external injury, intercurrent acute illness (especially febrile disease), vicious habits, straining efforts, and the like.

Prognosis.—The detection of a cardiac murmur should not alone lead to a gloomy prognosis. Says Osler: "With the apex beat in the normal situation and regular in rhythm, the auscultatory phenomena may be practically disregarded." Mackenzie rightly holds that the condition of the heart muscle is the most important criterion upon which to base the prognosis. Individual cases require separate and careful consideration. It is well not to advance positive assertions until all the circumstances that may influence the prognosis of any given instance have been well weighed. Observation of a case for some weeks and months enables the physician to speak with greater confidence and knowledge concerning the probable outcome. A high blood-pressure is an unfavorable sign, especially in cases in which chronic interstitial nephritis is associated (Satterthwaite). Prior to the occurrence of disturbances of compensation the prognosis is measurably favorable. After this pivotal event the prognosis as to life becomes wholly unfavorable in direct proportion to the extent of the degenerative changes of the myocardium. Disturbances of compensation that are attended with marked arrhythmia, urgent dyspnea, and general dropsy may admit of complete relief. Later, restoration of the balance of forces becomes only partial, and finally the above-mentioned symptoms become more pronounced; Cheyne-Stokes' breathing may then develop, and after prolonged and distressing struggle for breath the patient succumbs. Death

may also occur suddenly from ventricular fibrillation. Among ominous and yet common *complications* and intercurrent affections may be cited again extensive edema of the lungs, pneumonia, marked arteriosclerosis, embolic processes, ulcerative endocarditis, acute endocarditis, obstinate gastritis, and nephritis. On the contrary, *favorable indications* are sound general health, good external conditions (absence of poverty, hunger, etc.), strong and regular action of the heart, evidences of heart muscle which is functionally unimpaired, absence of arteriosclerosis, of excessive hypertrophy, of syphilis (unless recognized early), and of rheumatic antecedents, as well as any vices of life. Age influences the prognosis to some extent. In children under ten years the lesions are usually somewhat more rapidly progressive than in adults, and the compensatory hypertrophy is developed with corresponding rapidity; hence the period of failing compensation is reached earlier. This may be said to be a broad general rule, and I have found that it is one to which there are many exceptions. Among other reasons for the more gloomy prospect when heart disease occurs in young children are the following: the mitral valve is generally implicated, the liability to rheumatic interurrences is great, and there is a greater tendency to overtax the reserve cardiac power by violent forms of exercise. After the twelfth year the prognosis becomes more favorable. Sex is also a modifying prognostic factor, women bearing valvular lesions better than men, apart from the influence of childbearing, though even this is an influence the significance of which has been greatly magnified by many writers. To explain the more favorable outlook in women we have two main facts—viz., a less laborious as well as a more quiet life, and a diminished liability to arteriosclerosis and involvement of the coronary vessels. The particular valve involved has some influence on the prognosis.

Aortic regurgitation gives a fairly good prognosis in those cases that begin in early adult life, and in which the second sound in the neck is not abolished, granting that the patient regulates wisely his manner of living. A long, loud murmur indicates a strong heart with slight leakage. When the lesion is due to acute endocarditis, the prospect of life is better than when it originates in degenerative changes. A chief danger arises from associated arteriosclerosis—a frequent occurrence, particularly in advanced life—and from implication of the coronary arteries. Much depends upon the condition of the latter vessels. When their lumen is narrowed, starvation of the heart muscle quickly ensues, followed by myositic degeneration. Blocking of one of the branches of the coronary artery is the most frequent cause of sudden death in this affection. After failure of compensation, the prognosis is less satisfactory by far in aortic regurgitation than in mitral regurgitation, since restoration of compensation is not as readily accomplished in the former as in the latter variety. Taylor¹ claims that the gravity of the lesion, which is always serious, is lessened by the occurrence of ensuing mitral incompetence. Aortic regurgitation stands first among valvular affections in the order of gravity (Broadbent). In *aortic stenosis* favorable predictions are warrantable when the disease is uncomplicated. When the left ventricle gives way the condition is serious. Osler states that the rheumatic form of early life is more serious than the late sclerotic variety. The size of the radial artery is proportionate to the size of the blood-stream, hence indicative of the degree of stenosis.

Mitral regurgitation, when a primary lesion, is propitious, except in the very young, and not infrequently the progress of the morbid process is apparently arrested. In a considerable proportion of cases the disease does not materially shorten the life of the sufferer. In a larger percentage, however, there is special liability to a renewal of the causative affections (*e. g.*, rheumatism) and to

¹ *The Lancet*, London, July 15, 1916, p. 96.

monary conditions of serious import, producing exacerbations and permanent aggravations of the disease. The gravity of these intercurrent conditions is also increased by the existence of the cardiac lesion. If a good first sound is audible as well as the murmur, it is of good prognostic significance. Failure of compensation at once renders the prognosis decidedly unfavorable. In mitral stenosis compensation of the right heart fails somewhat earlier than in mitral insufficiency, and hence the accidents and conditions referable to the lung (diffuse pulmonary apoplexy, edema) are not so long delayed as in the latter disease. The greater tendency to fibrillation of the auricle that occurs in mitral stenosis as contrasted with other valvular lesions also causes the heart muscle to become functionally inefficient sooner than it would did not this complication occur. In my experience mitral stenosis is better borne by women than by men, and better during adolescence and early adult life than during more advanced years. The congenital forms are comparatively benign. Mitral stenosis causes sudden death more frequently than any other form of organic disease of the heart except aortic regurgitation. Tricuspid incompetency, whether secondary to disease of the lung or of the left side of the heart, is grave; it is extremely serious when it arises in the course of aortic incompetency. It is usually indicative of dilatation following hypertrophy of the right ventricle. Compensatory hypertrophy, however, can be re-established repeatedly.

Treatment.—This falls naturally into three subdivisions: (1) Prophylaxis; (2) management during the stage of compensation; (3) treatment of the stage of non-compensation.

(1) **Prophylaxis.**—The statistics of Sibson show that complete rest and protection of the surface during an attack of acute articular rheumatism lessen the average percentage of cases in which acute endocarditis develops. When the latter complication occurs in acute rheumatism the patient should keep to his bed for some time after all rheumatic symptoms have disappeared (two to six weeks) or until the improvement in the cardiac condition has ceased absolutely. This precautionary measure will often lessen the extent of the ensuing chronic endocarditis, and also increase the proportion of perfect recoveries. When the physician is cognizant of hereditary predisposition to organic heart disease, or has to deal with the alcoholic habit, he can frequently, by timely advice and hygienic suggestions, direct his patient to adopt measures that will obviate the occurrence of valvular disease. Systematic treatment of syphilis, until extinct, would greatly lessen the incidence of valve disease. All persons predisposed by heredity or otherwise should be told of the probable effect of muscular strain (*e. g.*, competitive sports), alcohol, and other exciting factors; too often, however, when he first sees his patient the physician is confronted by an incurable malady.

(2) **Management During the Stage of Compensation.**—Three main objects are to be accomplished: (a) The avoidance of every agency that tends to aggravate or maintain the lesion or lesions. Under this head the detection and removal of all causal factors is imperative. Thus, if the patient's vocation entails undue muscular effort, it must be abandoned; violent exercise, as running up flights of stairs, heavy lifting, or straining at stool, is dangerous and must be prohibited. If alcohol has been a factor, it must be discontinued; if syphilis, it must be treated specifically. A gouty taint must be overcome as far as possible by special measures. Fatigue and exposure must be avoided, particularly if the patient be young. Emotional excitement and mental overexertion injuriously affect the cardiac lesion; therefore tranquillity of mind should be insisted upon, though moderate and systematic mental exercise has no risks for the patient. In the case of children at school careful supervision of

ral disease, but is now more marked, and may be constant. The nutrition often suffers, and he is pale and rather feeble. Absolute oral feeding with suitable food, and iron may in a little while restore the cardiac tone. If this treatment fails, a small dose of digitalis should be given (5 minims—0.3—of the tincture three times daily). *Decided signs of lost compensation* are marked dyspnea and arrhythmia; the orthopnea; and cyanosis, with or without the presence of dropsy. (a) *Rest in bed.* This diminishes greatly the work of the heart, and thus helps to regain largely its former vigor. Rest joined with massage, careful oral feeding and attention to the bowels will often restore disturbed action in from one to two weeks. In a considerable number of cases at the Medico-Chirurgical Hospital this method succeeded admirably. *Cardiac stimulants and tonics.* Of these the most important is digitalis. It stimulates the pneumogastric, by causing the systole to be more complete and the period of diastole to be lengthened (prolonged conduction time, heart-block), thus increasing the blood-supply to the heart muscle, digitalis becomes an invaluable aid to the nutrition of the cardiac muscles. As a result of the use of this drug the tissue calls upon the cardiac forces from the other portions of the body are satisfied and the reserve energies of the heart are maintained.

Mitral disease the influence of digitalis is most beneficial, the pulse becomes slower, of better tension and more regular, while the urine increases in amount.

In mitral incompetency its good effects are ascribable in part to the increased contractions of the left ventricle, whereby the blood-stream from the left ventricle to the aorta is greatly increased. On the contrary, the patient's condition is occasionally aggravated by the drug, because "the leak is increased as the normal flow" (Hare). Digitalis exercises its most beneficial effect by rendering the systole of the right ventricle more energetic, the pressure being raised in the pulmonary circuit and left auricle; this helps the left ventricle better during diastole and "resists reflux through the mitral orifice in the systole" (Broadbent). In mitral stenosis digitalis, by prolonging the period of diastole, allows time for the blood to pass from the left atrium through the narrowed orifice into the ventricle. It is in auricular fibrillation that accompanies mitral stenosis that digitalis acts almost as a tonic. Toxic effects may sometimes result from digitalis, the first indication of poisoning is nausea and vomiting, signals that show that the drug should be temporarily stopped. If persisted in, heart-block occurs with marked slowing of the pulse as the most evident clinical manifestation. Under these circumstances digitalis should be discontinued.

Aortic regurgitation digitalis exercises a beneficial effect in cases dependent on chronic valvulitis: the theoretic view, however, that by prolonging the diastole digitalis causes overfilling of the left ventricle rests on too slender a foundation to be regarded as a valid objection to its use. It may, however, produce relative hypertrophy, in which case it should be withheld. High tension in a failing heart is benefited by digitalis, which lowers the pressure as a result of increased elimination and more efficient circulation (Norris). Digitalis is also powerless and probably harmful in proportion to the extent of atheroma and fibroid degeneration of the myocardium. When secondary dilatation comes on in aortic stenosis, digitalis is needed to increase left ventricular action. The dose is to be calculated according to the degree of cardiac exhaustion.

When tricuspid incompetency is secondary to mitral disease, striking results are obtained from the use of digitalis (*supra*); but when it exists alone—following emphysema or cirrhosis of the lung—digitalis often fails. The cardiac contractions, if they have previously been irregular, may become regular, but the precordial distress will often be increased, while the circulatory dis-

application exist. Strychnin, given hypodermically in full dose, gr. $\frac{1}{30}$ to (0.002–0.004), is an efficient stimulant. Newburg¹ and others have shown that strychnin is valueless as a heart stimulant *per se*, but it acts reflexly, increasing the stimulability of the vasomotor system and improving generally a patient's condition. It should be employed in this manner in sudden failure of heart power. Given in doses of average size its effects in chronic valvular disease are not striking. Atropin may be advantageously combined with it. Sugar by the mouth, 1 to 6 ounces, is recommended by Dr. Goulston in failing heart. It has also been given per rectum. In both forms of administration it supposedly supplies ready nutrition to the myocardium.

When the indications are urgent and the above agents are not available, fusible stimulants, as ether or ammonium, may be used until more suitable remedies can take effect. A single dose of strophanthin (gr. $\frac{1}{80}$ to $\frac{1}{20}$) may be used intravenously when there is urgent need for cardiac stimulation, or digitalinum as well. Cocain simulates strychnin in its action. The dose is gr. $\frac{1}{4}$ (0.016) every four hours, and the drug may be given with digitalis in pill form. There are two rapid ways of relieving the right heart:

(a) *Venesection*.—When the right heart is overdistended, as shown by its very feeble efforts at contraction, and the whole venous system is intensely engorged, as shown by marked cyanosis and orthopnea, bleeding directly from a vein is not only warrantable, but often imperatively demanded in order to save life. From 16 to 30 ounces (480.0–900.0) may be removed safely, and the heart's action will almost immediately be observed to grow stronger and more regular, and the pulse fuller and of better tension. As before intimated, the form of dilatation of the right ventricle that follows emphysema is disinclined to yield to digitalis. In such instances, following the suggestion of Osler, I have obtained brilliant results from free bleedings.

(b) *Depletion by purgation* affords less pronounced relief to the heart, though it is of the greatest value in cases in which a moderate grade of cyanosis and dropsy exist. As in the case of venesection, a feeble, irregular pulse is not a contraindication to the use of purgatives, since the latter remove directly a considerable portion of the heart's burden. The purgative to be used will vary with different cases. I select at the outset Rochelle or Epsom salts, employing them after the method of Matthew Hay—*i. e.* from 1 to 2 ounces (30.0–60.0) of Rochelle or 1 to 1½ ounces (30.0–45.0) of Epsom salts, in concentrated solution, to be given from a half to one hour before breakfast. Watery evacuations (three to six in number daily) usually follow the administration of the saline; but, unfortunately, one meets with many patients in whom it produces symptoms of marked catarrhal irritation. Next to salines, the most satisfactory results have been obtained from the use of elaterium; I often combine this with podophyllin and belladonna. I have never seen good results from the use of mercurials when the object has been to procure venous depletion, but they are of service in dropsy, and particularly in ascites.

Later, systemic tonics are often demanded by the *anemia* and other constitutional indications, and here iron and quinin should be joined with strychnin. Unquestionably, the value of iron in full doses as an aid in the completion of the work of restoring broken compensation has been and is still scarcely appreciated by the profession at large. When iron disagrees, arsenic may be given instead. In the treatment of syphilitic disease of the aortic segments, salvarsan may be employed; but it should be given in very minute initial doses and increased with great caution. In many cases of failure of compensation the restoration of the balance of the cardiosystemic circulation can be greatly assisted by depleting the overfilled venous system.

Schott of Nauheim has introduced a special treatment by baths and resist-

¹ *Amer. Jour. Med. Sci.*, 1915, cxlix, 696.

next two days an egg is added to this treatment, given about 10 o'clock in the morning, and a slice of dry toast, or zweiback, at 6 P. M. Then up to the twelfth day the food is gradually increased, first to 2 eggs a day, then more bread, then a little chopped meat, then rice or some cereal, and by the end of two weeks the patient is about back to his ordinary diet."¹ The Karell treatment should be carried out only in bed patients. One factor causing dyspnea in valvular disease is acidosis due to insufficient tissue combustion, hence Hoxie and others have advised the inhalation of oxygen.

(2) *Cough* is common after failure of compensation, and is due to bronchitis resulting from stasis in the pulmonary vessels. In mitral disease it may come on before the rupture occurs. Beyond the treatment directed to the causal condition (the cardiac failure) nothing is needed to relieve the cough. These subjects, however, are prone to suffer from catarrhal bronchitis due to cold, and this impairs the compensatory mechanism. J. Weiss extols heroin in cases not relieved by the ordinary remedies.

(3) *Hemorrhage* may take place, and generally from the lungs, though it may also proceed from the nose, stomach, bowels, or uterus. In a recent case of double aortic disease and relative mitral insufficiency hemorrhages occurred from the bowel with apparent relief to the patient. The hemoptysis, which is an accompaniment of mitral lesions, is rarely excessive, and is probably always beneficial. I would advise against active treatment unless the hemorrhage is actually copious in amount.

(4) *Palpitation* may be due to different causes, the recognition of which in each case is important. At times undue hypertrophy maintains a constant throbbing and distress in the precordial region, the condition being distinguished by the strength of the impulse and by the full, tense pulse at the wrist. Palpitation is best met by the use of the tincture of aconite, mj to iv (0.065–0.26) every four hours. With the aconite I frequently associate the bromid with excellent effect. An ice-bag to the precordia is worthy of recommendation. Unless the patient's discomfort is significant, however, this symptom does not call for active treatment. The administration of a saline purge not infrequently serves to quiet the heart. The patient may suffer from pure nervous palpitation, in which case the diet and the condition of the stomach must be carefully looked to, while for the throbbing the bromids of ammonium and sodium, together with preparations of valerian, are the most reliable.

(5) *Anginose Pains*.—These are seen in aortic incompetency accompanied by sclerotic vessels, and also in mitral stenosis. The former lesion is often due to syphilis (*vide* Etiology, p. 616), in which case the pains and other symptoms are best relieved by intensive antisyphilitic treatment. When dependent upon rigid blood-vessel walls nitroglycerin should be tried; if the attacks be severe, amyl nitrite by inhalation deserves a trial, this failing, morphin and atropin may be employed hypodermically. Local measures alone may be sufficient when the pain is only moderately intense, and the ice-bag may be tried. The sedative effect of a blister (4 by 6 in.—10–15 cm.) has more often proved effectual in my experience, though its use should be limited to patients whose general strength is not materially impaired.

(6) *Pain* referred to the stomach, and less frequently to the abdomen also, occasionally assumes prominence and is relieved with great difficulty. It is dependent, in part at least, upon obstinate subacute gastritis, and I have quite recently seen an instance of the sort verified by autopsy. Among many drugs tested in this case, opium alone gave relief. Should this fail, however, carminatives in combination with some antiseptic agent, as salol or guaiacol carbonate, should be used.

¹ *Jour. Amer. Med. Assoc.*, September 23, 1916, p. 952.

(7) *Gastric Symptoms*.—Soon after compensation is broken the appearance of mild symptoms of catarrh of the stomach may be said to be the rule, and these yield to simple measures in addition to the cardiac stimulants and laxatives already indicated. But there are not a few instances in which such symptoms as gastric distress and uneasiness, constant nausea with frequent vomiting, particularly after food, occur, and assume a distressing phase. In such cases digipuratum deserves a trial. These patients sometimes do well on the capsules before adduced composed of strychnin, spartein, and caffein. When the above remedies cannot be borne I employ hypodermically digitalin and strychnin or caffein citrate, the latter being made soluble by the addition of sodium benzoate in solution. Cases of this class reach an early fatal termination, as a rule. The symptoms may be partly due to uremic intoxication.

(8) *Nervous Symptoms*.—Insomnia and restlessness are almost constantly present at some period in the course of heart disease, and notably in the more advanced stages. The restiveness is rendered more distressing on account of hideous dreams and cardiac palpitation on awaking. For these phenomena stimulation often answers a better purpose than sedation. Hoffman's anodyne (3j—4.0, well diluted), spirits of chloroform (℥xv—1.0), or ether (3ss—2.0), taken in whisky (3j—30.0), are serviceable. The elixir of ammonium valerianate is also of value. Recently trional (gr. xv.) in combination with sodium bromid (gr. xx) has given satisfaction. Paraldehyd, veronal, and medinal are among the remedies of choice in the treatment of this symptom, but I have had no experience with their employment. In the later stages there is no objection to the use of morphin hypodermically. Headache due to uremia may frequently be a troublesome symptom in connection with sleeplessness, and in such cases morphin is the remedy *par excellence*; it is to be supplemented by free purgation and cardiac stimulants. Should the right heart be found flagging, venesection may be practised.

(9) *Dropsy*.—As above pointed out, rest with attention to the diet and the judicious use of hydrogogue cathartics will often restore broken compensation. In the severe grades of failure of the balancing forces, complete rest, purgatives, and a cautious employment of morphin hypodermically, often suffice to remove the dropsy. If this method of treatment proves unsuccessful, then the therapeutic indications, so far as the dropsy is concerned, are for the use of cardiac stimulants, diuretics, and purgatives. Diaphoretics, particularly the hot-air and vapor baths, are not to be thought of, since they tend to depress the already weakened heart. When digitalis fails to remove the dropsy, Fraenkel uses strophanthin intravenously, giving as the initial dose 0.5 mg. and repeating only when the favorable effect is no longer apparent. Where a more powerful diuretic action is desired than is afforded by digitalis alone, the diuretics of the purin group are combined, such as caffein, theobromin, theophyllin, or theocin, which act by dilating the renal vessels and by direct action on the epithelium. Of this group the most convenient form of all is the water-soluble acet-theocin-sodium in doses of about 3 grains three times a day (Hirschfelder). Members of this group, however, may diminish renal secretion when the kidney cells are much damaged, and a preliminary phthalein test, to determine the exact extent to which the renal epithelium is injured, should be made. For example, if the phthalein excretion is less than 30 per cent, in two hours, we should rely upon digitalis and other remedies that tend to improve the circulation rather than stimulate the kidneys. Nitro-glycerin may also be prescribed, especially in cases presenting evidences of advanced arteriosclerosis. Theobromin sodium salicylate has acted well in recent cases as a diuretic. An unirritating yet highly effective diuretic mixture in these cases is the following:

R. Potassii acetatis, 3j (4.0);
 Inf. digitalis, ʒij (60.0).—M.
 Sig. ʒss (15.0) every three hours.

Purgatives are of the utmost value. Frequently, after a few copious watery evacuations as the result of the action of hydragogue cathartics, a free discharge of urine can be established, when before the latter event it has been impossible. Salines and elaterium, with podophyllin and belladonna, are agents that have been already recommended as purgatives (to deplete the venous system), and these should be first employed in the order named. Compound jalap powder may also be combined with the elaterium. A course of calomel, followed by salines until free catharsis is set up, is valuable from time to time. Mercury is especially applicable when the liver is much enlarged and ascites is present or there is a history of syphilitic infection and a positive Wassermann reaction. It may be combined as follows:

R. Pulv. digitalis fol.,
 Pulv. scillæ, āā gr. xij (0.77);
 Mass. hydrargyri, gr. xxiv (1.55);
 Ext. belladonnæ, gr. ss (0.032).
 M. et ft. pil. No. xii.

Sig. One every three or four hours.

When efforts at relieving the dropsy by means of medicines fail, then the most dependent parts of the body, or those most swollen, should be scarified under strict aseptic precautions. Fine silver trocars with rubber tubes attached (Southey's tubes) may be inserted and the liquid allowed to drain off in a gradual manner.

Means to Prevent Recurrence of Broken Compensation.—When the compensation has been successfully re-established, the after-treatment must be prosecuted with vigor for at least a year. The cause of the rupture of compensation is most probably fibroid and fatty degeneration of the cardiac muscle, and hence the mere restoration of the compensatory power of the heart does not imply a complete cure of the impaired muscular structure of that organ. Much can be done, however, to overcome the tendency to degeneration by the persistent use of hematinics and other tonics, as cod-liver oil and mercuric chlorid, the latter in small doses. I have obtained excellent results from the use of the following prescription in these cases:

R. Liq. arsenici chlor., ℥xlviij (3.2);
 Tinct. ferri chlor., ʒss (15.0);
 Hydrarg. chloridi cor., gr. ss (0.03);
 Elixir digestivi comp., q. s. ad fʒiij (90.0).—M.
 Sig. 3j (4.0) after each meal, well diluted.

This preparation may be taken indefinitely with occasional brief interruptions. The patient should lead a very quiet life, and follow rigidly all hygienic rules that tend to prevent the production of valvular disease. In cases of aortic insufficiency vigorous antisiphilitic treatment is indicated. Frequently very small doses of digitalis may be indicated as a mild cardiac stimulant. Appropriate diet, it should be emphasized, is not inferior to appropriate medication in its salutary effect. Should the faintest evidence of failure of the right ventricle manifest itself, the patient must be put to bed and the foregoing treatment carried out. I am inclined to the view that the plan herein advocated not only renders the course of recurring attacks of failing compensation milder, but that, in a considerable proportion of the cases, the much-dreaded recurrence is thus prevented.

nical phenomena of cerebral, splenic, or renal *embolism* are exhibited. A *calicized* gangrene of the foot has been described.

The **physical signs** consist of a feeble impulse with marked arrhythmia; the area of dulness is somewhat increased to the right, and often upward; and the heart sounds are greatly enfeebled and quite irregular, with marked change in any murmurs that may previously have been audible. A presystolic murmur may be engendered.

Differential Diagnosis.—It is important to distinguish true cardiac thrombi, such as are above described, from the less dense and usually darker clots that are formed either immediately before or after death. The latter may seldom show an attempt at a very low grade of organization, and may present a somewhat decolorized appearance, but they do not adhere firmly to the endocardium. Moreover, *antemortem* and *postmortem* clots, as the latter may be appropriately termed, have a different causation from true thrombi. For instance, they are apt to form in diseases in which the fibrin-factors of the blood are greatly increased, as in pneumonia. Perhaps a more potent causal element is the progressive weakening of the heart muscle, resulting in partial expulsion of the contents of the right ventricle; the blood that remains in the chamber is merely whipped up, and the deposition of its fibrin must thus be greatly favored. Such heart-clots may be generated if the endocardium be healthy, and cannot be separated positively from true cardiac thrombi by clinical observation.

The **prognosis** is uniformly bad and sudden death may be expected.

Treatment.—Beyond measures calculated to meet the symptomatic indications nothing can be suggested.

HYPERTROPHY OF THE HEART

(*Hypertrophia Cordis*)

Definition.—Hypertrophy is an increase in the muscular structure of the heart, evidenced usually by an increased thickness of its walls. It is almost invariably associated with dilatation of the chambers.

Pathology.—When the two processes—hypertrophy and dilatation—coexist, they cause great enlargement of the organ. To this condition the term *eccentric hypertrophy* has been given. Hypertrophy without dilatation receives the name *simple hypertrophy*, and hypertrophy with diminution in the size of the cavities was formerly described as *concentric hypertrophy*, but this term should now be regarded as obsolete, inasmuch as the condition is due to postmortem contraction of the ventricles.

The increase in size may affect the whole heart, one chamber on either side, one whole side, or but a single cavity (*general* and *partial hypertrophy*). The process may also be limited to a minute division of the heart (*circumscribed hypertrophy*). Owing to its important physiologic function the left ventricle is more frequently enlarged than the right, while the right auricle is more frequently involved than the left. The *weight* of the normal heart in a man of average size is approximately 9 ounces (255.0); in a woman it is 8 ounces (256.0). In bilateral hypertrophy, however, the weight of the heart may be greatly increased; hearts weighing from 15 to 25 ounces (425.0–710.0) are seen in moderate grades of hypertrophy, and those from 40 to 50 ounces (1134.0–1420.0) in extreme cases (*cor bovinum*). Measurements showing the

athletes). Excessive bicycling causes hypertrophy, particularly if arteriosclerosis exists. (2) Constant overdistention of blood-vessels, as in the case of excessive beer drinkers (*beer-heart*). Here the direct action of the alcohol upon the heart muscle must also be taken into account. (3) Functional disturbances (neuroses), constant overaction of the heart (exophthalmic goiter), and even paroxysmal tachycardia, tea, coffee, tobacco, and alcohol may give rise to primary and general hypertrophy. Symmers,¹ in a recent study of the so-called idiopathic cardiopathy and its relation to goiter, calls attention to the fact that many cases of enlarged heart, apparently the result of primary disease of that organ, are examples of thyrotoxic cardiopathy in which the symptoms of thyroid disturbance are largely obscured by the cardiac signs and symptoms, of which tachycardia is the most constant. Idiopathic hypertrophy of the heart is undoubtedly due to increased activity, which is dependent on a variety of irritating influences acting upon the heart muscle (De Domenicis). *Primary congenital hypertrophy of the heart* is attributable either to circulatory disturbance or, as Virchow holds, to a diffuse myomatous neoplasia of congenital origin.

Hypertrophy of the right ventricle develops secondarily to any condition that offers obstruction to the pulmonary circulation or to the blood-current through the right ventricle. Among them may be mentioned—(1) Mitral incompetency and stenosis; (2) emphysema, chronic bronchitis, collapse of a portion of the lung, contraction of a lung from pleural adhesions, and cirrhosis of the lung; (3) right-sided valvular lesions, particularly obstruction at the pulmonary orifice; (4) it is doubtful whether, on account of the normal situation of the right ventricle, pericardial adhesions induce hypertrophy of this chamber.

Hypertrophy of the Auricles.—Hypertrophy with dominant dilatation of the left auricle occurs in mitral disease, and especially in mitral stenosis. The right auricle hypertrophies, though not invariably, when the blood-pressure in the pulmonary vessels is pronounced from any cause. Stenosis of the tricuspid orifice is occasionally the sole cause of thickening of the right auricular wall, which also becomes hypertrophied in tricuspid incompetency.

Symptoms.—There is usually an entire absence of subjective symptoms when compensation is efficient. When present, their intensity varies with the degree of the hypertrophy, which is then pronounced, as a rule, and often already attended by incipient dilatation. They may be *local* entirely, though frequently *general* as well. Of the former, *precordial discomfort* and *uneasiness* from the violence of the impulse occur. They are most annoying when the patient is in the recumbent posture on the left side and when the hypertrophy is dependent upon nervous causes. *Pain* and *palpitation* are seldom complained of except by neurasthenics and patients suffering from enlargement due to tobacco or excessive muscular exertion. Decided aggravations of the local manifestations may follow undue mental emotion or excitement, physical exhaustion, active bodily exercise, and gourmandizing.

The *general symptoms*, when present, may fluctuate or even intermit. Those most frequently observed are fulness in the head, often amounting to actual headache, *tinnitus aurium*, *carotid pulsations*, *flushing of the face*, *flashing of light before the eyes*, and often *prominent eyeballs*. These symptoms are attributable to the increased vigor of the cerebral circulation.

Remote Effects.—General or total hypertrophy promotes high tension throughout the arterial tree. Endarteritis and arteriosclerosis are, as a consequence, frequent simultaneous developments in advanced cases, especially when the cause of the enlargement has been increased tension in the peripheral vessels, as in Bright's disease. With a circulation too forcibly carried on, as

¹ *Arch. Int. Med.*, 1918, xxi, 331.

tion. When *dilatation* of the ventricle supervenes, as is usual, and the clinical evidences of tricuspid incompetency develop, then pulmonary symptoms, due to venous congestion, are prominent; there are bronchial catarrh, shortness of breath, and the like. Later, general cyanosis and edema appear. As pointed out in the discussion of Mitral Stenosis with permanently heightened tension and overgrowth of the right ventricle, the lung vessels become atheromatous and the lung tissue the seat of brown induration. Owing to the fact that the sclerotic vessels are easily ruptured, *hemoptysis*—a not uncommon event after sudden great exertion—is to be expected; intense pulmonary congestion and apoplexy may also be met with in hypertrophy with dominant dilatation.

Physical Signs.—These have been in the main detailed in speaking of affections of the mitral valve. *Inspection* discloses bulging of the sixth and seventh left costal cartilages and of the lower sternum. In the angle between the ensiform cartilage and the seventh rib an epigastric impulse may be visible, but more commonly the impulse is in the sixth interspace, close to the left edge of the sternum. It is also very generally seen to the right of the sternum, in the third and fourth interspaces, and particularly in this case in eccentric hypertrophy, forming a highly characteristic sign. The apex-beat is therefore diffuse, the radial *pulse* is small, and in dilated hypertrophy it is increased in frequency, and is small, unsustained, and irregular.

Percussion shows the extension of cardiac dulness to a point 1 inch (2.5 cm.) or more beyond the right sternal border. When there is great increase transversely, dilatation is most probably associated and may predominate over hypertrophy, though Mackenzie has shown that the dulness to the right of the sternum is largely auricular, and that right ventricular hypertrophy or dilatation is accompanied by a pushing over to the left of the area of cardiac dulness with the apex displaced down and outward. The *auscultatory* signs are not distinctive unless dilatation also exists, when the first sounds are clear and sharp. In simple hypertrophy the first sound is slightly prolonged and lower than in health. Owing to the high vascular tension throughout the lungs the second sound at the pulmonary valve is accentuated, and reduplication of the second sound may occur for the same reason.

It must be kept in remembrance that when advanced emphysema is present all the physical signs will be greatly modified, and may even be entirely negative, though the heart be of large size. Under these circumstances venous pulsation in the neck would be diagnostic of dilated hypertrophy of the right ventricle.

Hypertrophy of the Left Auricle.—This may be assumed to occur in mitral stenosis and incompetency in order to compensate for these lesions; it cannot, however, be recognized positively by physical signs. When the chamber is at the same time extensively dilated, the dulness may be extended upward to the left of the sternum, passing over the third and even second interspaces. At this point—the second interspace—a presystolic wave may now be noticeable.

Hypertrophy of the right auricle, associated with dilatation, is perhaps more common than its counterpart on the left side. It is secondary to tricuspid incompetency (rarely stenosis) and enlargement of the right ventricle, and hence has the same etiology as the latter conditions.

The *physical signs* are—systolic jugular pulsation, sometimes a presystolic wavy pulsation over the third and fourth interspaces to the right of the sternum, extension of cardiac dulness to the same interspaces, and other signs of tricuspid regurgitation.

Diagnosis.—The recognition of cardiac hypertrophy is possible only by attention to the physical signs and by means of the electrocardiograph. Next

ness, fully compensate for the causal condition—*e. g.*, as when a valve ruptures with startling suddenness. Failure of the cardiac nutrition at once renders the prognosis unfavorable. The cardiac sounds now give notice that the hypertrophy no longer meets the requirements of the case. The systolic pause grows longer (with abbreviation of the first sound), and the diastolic shorter. Occasionally, as the result of undue muscular exercise, acute dilatation, followed by a speedy termination of life, is observed. I believe that hypertrophy of the left ventricle warrants a more favorable prediction than can be made in hypertrophy of the right, and this for two reasons: first, the increased capacity for work of the left ventricle; second, the milder character of the many factors that are productive of left ventricular hypertrophy, as compared with those of the right. In special instances, however, the reverse may obtain, as when left-sided hypertrophy is associated with or caused by general arterial degeneration. It may be of advantage to the student and junior physician to recapitulate here a few of the chief points that are prognostically favorable as well as those that are unfavorable: *Favorable Conditions*.—(1) When the hypertrophic development fully compensates the causal lesion; (2) when the causes are removable or more or less amenable to treatment; (3) when the external conditions under which the patient lives, his habits, and general nutrition are good; (4) when the tests of functional efficiency of the heart show but little evidence of insufficiency. *Unfavorable*.—(1) When signs of cardiac insufficiency arise upon very slight effort; (2) when evidences of advancing cardiac dilatation (dyspnea, rapid, irregular pulse, edema) show themselves; (3) when poverty, poor food, intemperate habits, and an unhygienic environment are all combined; (4) when apparent cardiac vigor suddenly gives place to dilatation and great cardiac weakness.

The treatment has for its prime object the prevention of failure of compensation on the one hand and overhypertrophy on the other (*vide* Chronic Valvular Disease).

Overhypertrophy, as indicated by certain cerebral and thoracic symptoms, may require the employment of measures to reduce the contractile energy of the left ventricle, although direct cardiac depressants (aconite and the like) are rarely needed. It requires careful dietetic and hygienic management. Briefly, the *diet* should be nutritious, but the more concentrated forms of food should be used very sparingly, and the daily quantity should be slightly less than that required in health. It must be non-stimulating, and tea, coffee, alcohol in all forms, and smoking must be prohibited. The physical exercise should be moderate in amount and of the gentlest sort; and if the patient's occupation tends to stimulate the heart, it must be immediately abandoned. A mild saline purge (3ij to ʒss—8.0–16.0—of Rochelle salts once daily) is quite beneficial.

For relief of the cerebral symptoms (tinnitus aurium, vertigo, fulness) and the precordial discomfort the physiologic relaxants of the capillaries and the arterioles are of great service, particularly when arteriosclerosis is a traceable cause. Among them nitroglycerin in full doses and veratrum viride are most useful; the efficacy of both may often be enhanced by the addition of the bromids. In cases of nervous origin the bromids, with preparations of valerian, are the most valuable agents. Nothing, however, is of higher importance than the determination and removal of the cause when possible. After compensation has failed the further treatment is identical with that of cardiac dilatation.

DILATATION OF THE HEART

Definition.—By dilatation of the heart is meant an enlargement of its various cavities. The walls of the chambers may in consequence be thinner than in health, but much more commonly they are thicker, as in *dilatation with hypertrophy*. Both hypertrophy and dilatation are relative terms, but the latter has reference to that condition in which the cavities are distended out of proportion to the diameter of their walls.

Varieties.—(1) *Dilatation with Hypertrophy.*—Here there is a progressive increase in the capacity of the chambers until they attain to large dimensions. The cardiac walls continue of abnormal thickness, yet the vigor of the divisions affected may be relatively diminished to a remarkable degree, owing to the weakening influence of the degenerative processes that attack the hypertrophied muscles. In eccentric hypertrophy the heart cavities are dilated, but the hypertrophied cardiac walls are sufficiently vigorous to meet the demands of the circulation. This condition should not be regarded as identical with *dilatation with hypertrophy*, but frequently merges into the latter, the size of the cavities now being proportionately greater than is the thickness or the functional power of their walls.

(2) *Dilatation with Thinning of the Heart Walls.*—The diminution in the thickness of the cardiac muscles may be slight if the capacity of the chambers involved be only moderately increased. Instances of this sort are sometimes seen to follow prolonged fever (typhoid). On the other hand, the process of attenuation may reach a high grade, the greatly thinned cardiac wall being scarcely capable of holding the weight of the contained blood.

(3) *Dilatation with little or no variation from the normal cardiac wall* has also been described by some authors. It is to be observed, however, that stretching of a cavity whose walls are of normal thickness must be attended with thinning of those walls.

Pathology.—Dilatation with hypertrophy is generally secondary to valve lesions, and affects more than one cavity as a rule. It may happen, as in advanced aortic regurgitation, that all the divisions are dilated. The right ventricle is somewhat more frequently dilated than the left, however, for reasons previously adduced. The auricles (especially the left) are more frequently expanded than the ventricles; hence of all the chambers the left ventricle is least apt to dilate. The extent of the relative increase in the capacity of the cavities is variable and often remarkable. As an example of extreme dilatation of a chamber, the left auricle in cases of mitral stenosis may be singled out; I have seen an instance in which this auricle was capable of containing 22 ounces of blood. The septum may be seen to bulge when one ventricle only is stretched. Extensive dilatation of the chambers produces a dilated condition of the auriculoventricular rings, which in turn gives rise to relative incompetency. Other cardiac orifices are found to be similarly dilated. Dombrowski has drawn attention to the fact, first pointed out by Wolf, that the surface of the mitral leaflets greatly exceeds the orifice, and Kirschner and Garcin contend that the anterior flap alone suffices to close the mitral orifice, "even when the left heart is considerably dilated." Dombrowski believes that functional incompetency is due, in many cases, "to muscular dilatation, producing a separation of the insertions of the papillary muscles, which in systole cannot approach each other near enough to allow the valves to close, the contraction of the papillary muscles only increasing the difficulty." Great dilatation of the left auriculoventricular ring is, however, probably an important factor in the causation of relative mitral incompetency. The tricuspid

lves, being scarcely competent normally, are unquestionably incompetent when that orifice is considerably dilated.

The *shape* of the heart is altered according to the seat and extent of the dilatation. When all the cavities are dilated the organ assumes a globular form, while dilatation of the ventricles only produces broadening of the apical region.

Condition of the Endocardium and Cardiac Muscle.—The muscular tissue generally exhibits degenerations (fibroid, fatty, or parenchymatous). Important as is the part played by the ganglia in maintaining the nutritive integrity of the heart by supplying nervous force, our knowledge of the alterations that may occur in them in this condition is as yet very imperfect. Ott and others have, however, found them to be degenerated. Opacity and patchy roughening of the endocardium are common. The parietes and endocardium may, however, have a normal color and structure.

Etiology.—Entering into the causation of cardiac dilatation there are two essential factors: (1) increased endocardial tension; (2) diminished resistance. These often act together. Broadbent contends that the special feature of dilatation is the imperfect emptying of the ventricles. Probably the most important factor is the disturbance of the coronary circulation that arises as a result of the increased tension in the right auricle, which impedes the return of the coronary blood into the right auricle (MacCallum).

(1) *Increased Endocardial Tension.*—It is to be premised that a primary and a secondary form occur, the latter being of greater importance clinically than the former. Primary dilatation occurs from a recent obstruction to the circulation of considerable magnitude and at any point throughout the blood-vessel system. A good example is afforded by aortic constriction, in which condition the obstruction of the aortic ring engenders dilatation of the left ventricle by raising the intraventricular pressure; this is quickly overcome by compensatory hypertrophy. In the vast majority of these instances the nutrition of the muscular fibers eventually suffers, with consequent dilatation.

Other causes of augmented endocardial pressure have been considered in the discussion of Hypertrophy and Chronic Valvular Lesions. In eccentric hypertrophy dilatation is a compensatory arrangement, until finally the cardiac nutritive functions fail and dilatation at once predominates (dilatation with hypertrophy). Compensation has now been ruptured. Among the exciting factors that may precipitate this accident are—recurrent endocarditis, intercurrent febrile affections which overstimulate the heart and impair its muscular tissue, general disturbances of nutrition, and physical and mental overstrain.

Acute primary dilatation may be brought about by sudden, great exertion, as in ascending mountainous elevations, excessive bicycling, and the like. Under these circumstances the heart palpitates violently, and there are epigastric pulsation and often pain in the cardiac region—evidences of dilatation of the right ventricle. Although the heart's reserve capacity for work has been exceeded, rest followed by moderate exercise often restores the conditions to the normal. I have seen acute primary dilatation produced by strong emotion; here sudden contraction of the peripheral vessels occurs, attended with arrest of the heart's action; this soon gives place to violent palpitation and, rarely, to dilatation. *Angiospastic dilatation* is a condition due to acute transitory spasm of the vessels. Sudden fright may act similarly.

The remarkable endurance of the athlete and the gymnast is in part owing to the abnormal amount of physiologic cardiac reserve force which they naturally possess, but it is mainly due to the invigorating effect of training. However, the training be not so conducted as symmetrically to develop the entire muscular system, or if the exertion be in excess of the reserve func-

small (rarely large), short, often rapid, and irregular. Palpation of the pulse should always be combined with the use of the sphygmomanometer, which may show an unexpected exaltation of the blood-pressure, especially when dilatation develops somewhat abruptly. *Percussion* shows a lateral increase in dullness to the left, to or even beyond the midclavicular line, upward to the second rib, and downward as far as, though rarely below, the sixth interspace, except perhaps, in rare instances, in dilatation with hypertrophy. In emphysema the lungs unduly overlap the heart.

Dilatation of the right ventricle demands separate consideration so far as the impulse and percussion-dullness are concerned. The normal impulse is largely replaced by the abnormal apex-beat of the right ventricle, which advances to the anterior chest wall. The chief impulse is now seen and feebly felt, as a rule, below the xiphoid cartilage or, less commonly, to the right or left of the latter. A wavy pulsation is seen to the left of the sternum, over the fourth, fifth, and sixth interspaces and close to its right edge. If dilatation of the right auricle be associated, as is often the case, a distinct pulsation also occurs in the third right interspace. Dullness reaches to a point 1 inch (2.5 cm.) or more beyond the right sternal border on a level with the fourth interspace.

On *auscultation* variable results are obtained according to the state and diameter of the cardiac walls. When thin and not much disorganized, the first sound is much shorter, sharper, and louder than in health. In advanced cases the systolic sounds may be feeble, though almost always audible in the aortic area (unlike the first sound in hypertrophy). The first closely resembles the second sound, the long pause being shortened, resembling the systolic pause (*fetal heart sounds*). This form of arrhythmia is a serious indication of failure of the ventricles. The *canter-rhythm* is equally common. Irregular and intermittent cardiac action are usual phenomena. Reduplication may occur, but is not frequent.

Pre-existing *organic murmurs* obscure the sounds due to dilatation, and, on the other hand, the dilatation may also alter the murmurs (previously audible), and even cause them to disappear, as, for example, in mitral stenosis. Again, dilatation may induce relative incompetency or superadd a murmur, as in cases of chronic valvular disease at the auriculoventricular orifices. It is interesting to recall here that proper treatment may remove a murmur due to relative insufficiency, and that this treatment may, in turn, reproduce an organic murmur.

Diagnosis.—This is made readily when there is obtainable a clear history, together with the following characteristic features: a weak, irregular heart action (throbbing of the precordium); an extended, wavy impulse; a small, vigorless, and intermittent pulse; often an indistinct apex-beat; an outward, upward increase in the percussion-dullness on one or both sides, causing the outline to resemble a square; and a brief, sharp, yet feeble first sound that resembles the second, which is enfeebled.

Differential Diagnosis.—*Hypertrophy*, like dilatation, gives rise to an extended area of impulse and of percussion-dullness; hence by the careless observer these conditions are sometimes sadly confounded. From dilatations, in which the diagnosis rests upon the points above enumerated, hypertrophy is to be distinguished by symptoms of an opposite nature, such as indicate increased energy on the part of the heart. The latter are: a slow, heaving impulse; a full, sustained, regular pulse; an increase in the area of dullness, chiefly outward and downward; abnormal position of the apex-beat; and the prolonged, dull first and accentuated second sounds. To determine the point at which eccentric hypertrophy ends and dilatation (with hypertrophy) begins

is often difficult; and I have already discussed the initial symptoms of dilatation following hypertrophy (chiefly of the right ventricle) in connection with Chronic Valvular Disease. Occurring in left ventricle hypertrophy, dilatation first betrays itself by a change in the position of the visible apex-beat and the palpable impulse. Thus, the maximum point of the apex-beat of hypertrophy very early becomes rounded and indefinite, and later is diffuse and wavy. The strong, heaving thrust of the impulse gives place to the shorter, more sudden shock of commencing dilatation, indicating weakness. These signs, together with a reduction in the strength and an increased frequency or irregularity of the pulse, show the condition to be dilatation with hypertrophy.

The **prognosis** is bad, as a rule, being that of the causative factors. Here prognostic information may be gained by a careful study of the functional efficiency of the myocardium. The functional capacity of the heart may be tested. For example, with improvement in the general condition and myocardium, the amount of muscular exercise that can be done before a delayed rise in systolic pressure ensues becomes greater and greater. The gravity of the prognosis is in direct relationship to the severity of myocardial impairment. A dilatation occurring after sudden physical effort, for example, may be so mild that after rest for a period the heart may regain its full functional power. A dilatation that occurs in the course of chronic valvulitis may be so severe that even after prolonged rest the functional power of the heart never returns; the myocardium is inefficient.

Treatment.—This in all essential particulars is identical with the treatment of organic heart affections after rupture of compensation. The etiology in many cases differs from that of the organic valvular affections of the heart; and the removal of the remote and near causes of the dilatation is the most important part of the treatment. Individual cases frequently present special indications; but in all the work of the heart is increased and the propulsive power of the organ diminished. The indications are to diminish the heart's labor by bodily and mental rest, light diet, purgation and relaxing the peripheral vessels (T. A. Claytor), and to increase the functional power of the heart by the use of cardiants, baths, and massage. In cases of non-valvular origin digitalis and other heart stimulants may be omitted early, as a rule; though they should be resumed if there be a recurrence of serious indications of dilatation. When the dilatation has been overcome, careful attention is to be bestowed upon all the details of the patient's life and sanitary surroundings in order to force his bodily nutrition to the utmost. Every precautionary measure having for its aim the prevention of a recurrence of the dilatation must also be advised and enjoined.

MYOCARDITIS

(*Carditis*)

Definition.—An inflammation of the muscle substance of the heart. It may be acute or chronic.

ACUTE MYOCARDITIS

Pathology and Varieties.—(1) **Acute Parenchymatous Myocarditis.**—This is characterized by a granular degeneration of the muscular fibers of the parenchyma of the organ, with a numerical increase in their nuclei. The

muscle structure throughout looks pale, is turbid, and very soft. Many cases of a severe type terminate in fatty degeneration.

(2) **Acute Diffuse Interstitial Myocarditis.**—Here the primary alterations affect the connective tissue of the myocardium; the histologic changes consist in round-cell infiltration.

(3) **Acute Circumscribed Myocarditis.**—In this variety the degenerative processes result in necrosis of the tissues over large or small areas, with abscess formation. Though usually multiple, these abscesses vary in number, and may rupture either into the various cardiac chambers or into the pericardium. Thus, the purulent contents of the abscess, when there is established a fistulous communication with an endocardial chamber, find their way into the bloodstream, frequently setting up embolic processes of an infectious nature in the various viscera. The blood, in turn, enters the abscess cavity, exerting pressure on its walls, and may either produce an acute aneurysmal dilatation of the heart wall or occasion fatal rupture into the pericardium. More commonly the connective-tissue wall of the abscess yields gradually during the ventricular diastole. Occurring in the vicinity of one of the auriculoventricular valves, abscesses may cause mitral or tricuspid incompetency. They may perforate the interventricular septum, thus creating a fistulous connection between the two sides of the heart, and resulting in an intermingling of venous and arterial blood. The abscess may become encysted, then caseous, and finally undergoes a calcareous process. Multiple abscesses usually affect the left ventricle.

Etiology.—*The causes of myocarditis* are: (a) endo- and pericarditis in the course of rheumatism; it is probable that rheumatic myocarditis may also exist without involvement of the endo- or pericardium, though most cases of rheumatism are associated with a pancarditis; (b) the infectious processes in acute specific fevers (influenza, diphtheria, typhoid); (c) infectious emboli, lodging in the branches of the coronary arteries in connection with septicemia, pyemia, and acute ulcerative endocarditis, and commonly terminating in abscesses (circumscribed myocarditis). The first two of these causes give rise to acute diffuse interstitial and acute parenchymatous myocarditis, as a rule, although Freund calls attention to the frequency with which circumscribed myocarditis is associated with rheumatism and diseases of the joints. As compared with the female sex, the male suffers much more frequently.

Symptoms and Diagnosis.—The symptoms are practically negative. They point merely to great enfeeblement of cardiac function. When cardiac weakness, as shown by a rapid, small, compressible, and arrhythmic *pulse*, and by attacks of *cardiac palpitation* and *syncope*, comes on suddenly in the course of rheumatism, septicemia, or other causal affections, myocarditis may be suspected. Later, signs of *venous stasis* appear. The systolic blood-pressure is commonly low, though fluctuating, varying from 100. to less than 80 mm. Hg. The *mental symptoms* may suggest meningitis or salicylic acid poisoning. Koplik calls attention to certain symptoms (pallor, faintness, vomiting, irregular, feeble heart action, disturbed respiration, and pulse-ratio) that should arouse suspicion of myocarditis in the course of an infectious disease in childhood.

The **physical signs** simulate those of dilatation, and may, indeed, be largely dependent upon the presence of the latter condition. Early the action of the heart is tumultuous; the sounds on auscultation are short, sharp, and finally very feeble. *Murmurs* in myocarditis are not rare, and are not necessarily dependent upon dilatation. Krehl's work shows the dependence of the valves for their complete closure upon a normal state of different portions of the heart muscles, and thus explains these murmurs. The special conditions rendering

the murmurs audible are great dilatation, softening of the papillary muscle, and abscesses near the valves.

The great variability as to the intensity of these murmurs is an important point, especially in attempts to discriminate from murmurs due to *endocardial changes*. The latter usually coexist with a more marked accentuation of the second pulmonary sound. For the recognition of *cardiac aneurysm*, see p. 653. The symptoms of visceral or cutaneous *embolic processes*, combined with a murmur and a septic type of fever, are suspicious of the existence of circumscribed myocarditis. The murmur of relative tricuspid regurgitation and the venous pulse may eventually develop, accompanied by the symptoms of general venous engorgement.

Prognosis.—The diffuse forms are often fatal; the circumscribed form rarely eventuates in recovery. Myocarditis may end life suddenly.

The **treatment** is identical with that indicated for endocarditis and pericarditis—diseases of which myocarditis is usually a complication. The effects of digitalis, particularly when acute insufficiency supervenes upon old heart lesions, are quite unsatisfactory (insufficient intact heart muscle), but diffusible stimulants—*e. g.*, aromatic spirit of ammonia, brandy, and the like—are useful. When myocarditis is suspected as an independent condition absolute rest must be enjoined, the general nutrition maintained, and the more urgent symptoms relieved.

CHRONIC MYOCARDITIS

(*Fibrous Myocarditis*)

Definition.—A gradually developing inflammation of the cardiac interstitial connective tissue, resulting in induration.

Pathology.—The characteristic changes may be diffuse, though most frequently they are confined to certain portions of the muscular structure, the left ventricular wall, the septum, and the papillary muscles being the three favorite seats of the process. This is sometimes of antenatal development, and then its usual seat is near the apex of the right ventricle. The hardened spots take the form of more or less rounded patches or broad lines. In color they are gray, grayish-white, or grayish-yellow, the latter tint being due to the intermingling of fibers that have undergone fatty degeneration. Their size is exceedingly variable, some being so minute as to elude detection by the unaided eye, while others measure 1 or 2 inches (2.5–5 cm.) in diameter. Inflammatory induration (contraction) of the *conus arteriosus* of either ventricle causes narrowing of the pulmonary and aortic orifices, with the usual signs and symptoms. Similar changes, by disturbing the functions of the papillary muscles, produce valvular incompetency. Compensatory hypertrophy of the uninvolved portion of the heart is also observed; the hypertrophic enlargement may frequently be accounted for in part either by an associated chronic endocarditis or general arterial sclerosis. Dilatation of the ventricles follows, with fresh and grave disturbances of the circulation.

Chronic inflammation usually attacks early the intima of the coronaries, and leads to thrombosis, with the formation of anemic infarcts (*vide* p. 666). It is probable that most cases of localized fibrous myocarditis have their origin in an obliterating endarteritis. Pasquier offers proof that myocarditis results from chronic congestion due to stopping of the vessels. The calloused zone may yield to the endocardial blood-tension, and thus produce saccular dilatation (aneurysm). *Microscopically*, the affection is characterized by hyperplasia of the interfibrillar connective tissue with subsequent development of new fibrous tissue. Fatty degeneration and atrophy of the muscle-fibers

due to compression) are also observed. Fragmentation of the muscle-fibers (the *état ségmentaire* of Renant) has also been observed. This occurs as a *postmortem* change.

Etiology.—The disease is most commonly traceable to the action of one or more of the following factors: an *excess in the use of alcohol or tobacco, lead-poisoning, phosphorus, gout, rheumatism, diabetes, chronic nephritis, malaria, and syphilis*. Thus, it may be produced by many infections and chemical irritants, the latter, in most cases, first causing a sclerosis of the coronary arteries, to which the patchy fibroid degeneration is secondary. Some of the causes of acute diffuse interstitial myocarditis may by their more slightly irritant effect lead to the subsequent development of the general chronic form (e. g., rheumatism). Certain irritants that engender localized lesions of chronic myocarditis may affect the entire myocardium (syphilis, alcohol, gout). Certain exhausting diseases, as dysentery, carcinoma, and the anemias, may act as causes. Longcope's studies show that repeated absorption of proteins from the intestines may injure the heart muscle. There is a small group of cases due to a primary local focus in some organ other than the heart, e. g., the teeth, tonsils and, as pointed out by Babcock and Lichty, disease of the gall-bladder. Chronic myocarditis may arise in consequence of a *direct extension* of the inflammatory processes in chronic endo- and pericarditis; it may also follow *injuries* of the anterolateral thoracic region. *Sex* and *age* possess a predisposing effect, the disease being more common in males, and after middle life than before that period. The right ventricle is apt to be the seat of chronic myocarditis during fetal life, if at all.

Symptoms.—Extensive indurated myocarditis has been met with *post-mortem* in numerous instances that have been unattended by perceptible symptoms during life. In many of these cases the presence of compensatory hypertrophy accounts for the absence of any symptoms, and it may, therefore, be inferred that mild grades that fail to manifest themselves must frequently exist. The symptoms when present are, almost without exception, untrustworthy for diagnostic purposes, since they bear a striking resemblance to those of the organic valvular diseases minus their more characteristic physical signs. Among the earliest phenomena that point merely to failing heart power are *dyspnea*, and sometimes also, on exertion, *palpitation* and a *sense of heaviness or constriction* in the precordia. The patient suffers from marked general debility, and becomes *fatigued* in consequence of the slightest physical exertion. *Mental inertia* is the rule, and *chronic mania* may come on and last to the close. Later, more positive disturbances of the circulation gradually arise, and when the breathing becomes more difficult (*cardiac asthma*) signs of *venous stasis* affecting the liver, gastro-intestinal tract, and kidneys, and edema finally appear.

Two symptoms that are frequently manifested, and not without some diagnostic import, remain to be mentioned: (1) *Angina pectoris*, which is attributable to the sclerosed condition of the coronary arteries. (*Vide Angina Pectoris*, p. 686.) It is often followed by some form of arrhythmia. Recurring paroxysms of angina pectoris, with or without arrhythmia, may be the only phenomena of the disease.

Bradycardia is associated as a rule, there being a reduction in the pulse-rate to 50 or even 40 beats. With this decreased rate various forms of disturbed rhythm are also observed—e. g., the phenomena of the Stokes-Adams syndrome and extrasystoles. Slowing of the pulse does not prohibit the cardiac palpitation that is apt to arise during anginal attacks. Arrhythmia, however, may be entirely absent.

Chronic myocarditis may be the sole cause of the *pseudo-apoplectic seizures* that often terminate life abruptly. Preceding the unexpected attack the

value in determining the state of the myocardium. This, Mackenzie says, is the important factor in prognosis and treatment. The same authority says that in estimating the functional power of the heart greater dependence can be placed upon symptoms (*e. g.*, slight dyspnea, cough, gastric disturbances, and so on) than upon physical findings.

The treatment should be managed according to the considerations pointed out in the treatment of Organic Valvular Disease. Rest of body and mind is imperative. Next to this come the dietetic and hygienic details. Residence in a mild climate in winter and a change to the country or to a moderate elevation in summer are advisable. Cases caused by syphilis are favorably influenced by the iodids. Those rather frequent cases that present such closely united conditions as arteriosclerosis, gout, and chronic nephritis sometimes do well while sojourning at certain mineral springs, such as Marienbad, Carlsbad, Kissingen abroad, and Bedford or Saratoga at home. These waters must, however, be cautiously used. Bell, after excluding advanced arterial fibrosis, aneurysm, and advanced cardiac insufficiency with dropsy, recommends saline baths administered in a manner similar to the artificial Nauheim baths (*vide* p. 644). The so-called "Karell cure" gives favorable results in that type of cardiac disease seen in senility, emphysema, chronic alcoholism, and cachectic states.¹ The Oertel cure (protein diet, restriction of fluid intake, graduated exercises up hill) may prove serviceable.

When dilatation arises digitalis is called for, but must be used with an unusual degree of caution. Christian² says that in spite of the disrepute that digitalis has fallen into in the treatment of myocarditis, particularly when associated with a slow pulse, it is undoubtedly beneficial when properly administered in cases with decompensation. By proper administration Christian means giving enough of the drug to produce an effect upon the kidneys, the stomach, or the respiration. Failure to use digitalis properly is either the result of insufficient dosage, as ordered by the physician, or the result of administering an inefficient preparation. Strychnin has proved itself to be valuable as a general tonic and stimulant if perseveringly exhibited. The prolonged use of camphor in small doses has been found to be useful in keeping up the tone of a heart with a myocarditis. For the angina pectoris morphin, administered hypodermically, is to be preferred. Recurrences of this distressing symptom may be averted by the cautious use of nitroglycerin, the use of which should, however, be limited to cases that seem to be dependent upon arterial degeneration with high tension. Attacks of syncope are most successfully met by the hypodermic use of diffusible stimulants (ammonia, ether), and at the same time by putting the patient at rest with the head lowered.

¹ See Goodman, "The Use of the 'Karell Cure' in the Treatment of Cardiac, Renal and Hepatic Dropsies," *Arch. Inter. Med.*, 1916, xvii, 809.

² *Amer. Jour. Med. Sci.*, 1919, clvii, 593.

DEGENERATIONS OF THE HEART

(a) FATTY.—The term “fatty heart” includes two pathologically distinct sections: (1) Fatty degeneration, in which the cardiac muscle-fibers have been converted into fat; and (2) fatty overgrowth, in which an abnormal quantity of fat is deposited in and about the heart. According to Leyden, the cases of “fat-heart” (fatty overgrowth) are divisible into two substances: (a) fatty overgrowth, and (b) fatty infiltration.

FATTY DEGENERATION

Pathology.—The condition may be either general or localized. Its most frequent seat is in the left ventricle, the papillary muscles and trabeculæ, first appearing as yellowish spots or stripes beneath the endocardium. The affected portions are light yellow or yellowish-brown (faded leaf) in color, due to an associated brown atrophy; they are soft and friable, and are easily lacerated. The heart is enlarged and its walls lack firmness. The microscope reveals characteristic changes: the striæ and nuclei begin to fade, oil-drops and granules appear in the fibers, and finally the latter are occupied throughout by minute globules.

Etiology.—Fatty degeneration, as already mentioned, occurs in both the primary and secondary forms of *cardiac hypertrophy*. It is found, in association with fatty change in other organs, in severe forms of *primary* and *secondary anemias*. It is most common, however, in the *cachectic states* produced by such chronic diseases as carcinoma and phthisis, and in the course of *acute infectious diseases* of intense type. Warthin finds that focal or diffuse fatty degeneration of the myocardium may be associated with numerous spirochetes of syphilis without interstitial change. In poisoning by arsenic and phosphorus and in pernicious anemia it advances to a high grade. The various lesions of the *coronary arteries* previously considered bear the most significant causal relation.

Predisposing causes are: (a) *age*—it being most common after forty years of age; (b) *sex*—it occurs somewhat more frequently in men than in women, notwithstanding the fact that there are predisposing influences at work in the latter that do not obtain in the male sex, such as childbirth; and, lastly, (c) whatever may be its apparent etiology, it is invariably preceded by a defective nutritive supply to the muscle-cells: this may be dependent upon a narrowing of the lumen of the coronary vessels, or upon impairment of the oxygen-carrying power of the blood, as in the anemias. An excessive supply of glucose, glycogen, and nuclein may be a factor.

Symptoms.—The disease may exist in an advanced form without noticeable symptoms, though the conditions under which it is most liable to occur afford secure ground for suspicion. The evidences of *cardiac enfeeblement* are usually present, but in pernicious anemia and chlorosis the pulse may even be full and regular.

Dilatation is apt to supervene early, owing to the weakened state of the heart; and hence many of the symptoms are due to secondary dilatation. Among these are *palpitation*, *dyspnea*, a *small, irregular*, and somewhat *quickened pulse*, and *cool and clammy extremities*. The heart sounds are weak, as a rule, and the action of the heart often irregular. *Dropsy* is rare in uncomplicated cases. Sometimes sudden, great physical exertion produces equally sudden dilatation, whereupon a canter-rhythm and an apical systolic murmur develop. In most instances, however, the symptoms of dilatation are more gradually brought to light. *Breathlessness* on exertion is often a striking feature, and syncopal attacks are sometimes troublesome. The *pulse* often

A strictly horizontal posture and the application of ice to the precordial region often quickly terminate the attacks of cardiac asthma, and spartein sulphate, with nitroglycerin, is worthy of a trial. Hot toddy and other diffusible stimulants are valuable adjuvants. Should these remedies fail, hypodermic treatment by morphin is to be adopted.

FATTY OVERGROWTH

Pathology.—The normal fat, particularly in the auriculoventricular furrows, is increased. I have elsewhere suggested the term “subpericardial overfatness,” to indicate the condition when unaccompanied by fatty infiltration. This overproduction of fat may become so excessive as to form a complete enveloping mantle measuring an inch or more in thickness. In these extreme grades the muscular fibers may, from too great pressure, undergo atrophy and thus become weakened.

Etiology.—The principal cause is general corpulency. (For a consideration of the factors predisposing to fat production, see Obesity.) In the cachexias of carcinoma and phthisis, and the general atrophy of old age, fatty overgrowth and fatty degeneration coexist.

Symptoms.—The condition may be unaccompanied by any symptoms. The muscle-fiber is weakened (not degenerated, as a rule), hence extra labor suddenly thrown upon the organ excites the clinical indications of a weak (dilated) heart, as urgent dyspnea, vertigo, syncope, palpitation and cyanosis. Later, recurrences arise on every provocation. Distressing attacks of asthma may develop after a full meal or without an apparent exciting cause. A passive form of bronchitis may supervene. The cardiac impulse is feeble and may even be missing. The pulse is, as a rule, regular and moderately tense. Slight intermittence and, in marked heart weakness, decided arrhythmia may be noted. In moderate grades the heart-sounds may be clear; in marked cases with ensuing dilatation a systolic, apical murmur may be audible.

The diagnosis rests upon the combined presence of marked obesity and cardiac enfeeblement. (For the differential diagnosis, see p. 664.)

Treatment.—I wish to advocate warmly the system of treatment introduced by Oertel, as I have seen excellent results from its employment. It should not be resorted to in chronic valvular disease, in the stage of broken compensation, nor in marked atheroma.

Oertel's method comprises three parts: (1) The reduction of the amount of liquid taken with the meals and during the intervals, the total for each day being 36 ounces (1 liter). Frequent bathing (including the Turkish bath in suitable instances) and pilocarpin are employed to promote free diaphoresis.

(2) The diet is composed largely of proteins, as follows: *Morning.*—A cup of coffee or tea, with a little milk—about 6 ounces (180.0) altogether; bread, 3 ounces (90.0).

Noon.—Three to 4 ounces (90.0–120.0) of soup; 7 to 8 ounces (210.0–240.0) of roast beef, veal, game, or poultry, salad or a light vegetable, a little fish; 1 ounce (30.0) of bread or farinaceous pudding; 3 to 6 ounces (90.0–180.0) of fruit for dessert. No liquids at this meal, as a rule, but in hot weather 6 ounces (180.0) of light wine may be taken.

Afternoon.—Six ounces (180.0) of coffee or tea, with as much water. An ounce of bread as an indulgence.

Evening.—One or two soft-boiled eggs, 1 ounce (30.0) of bread, perhaps a small slice of cheese, salad, and fruit; 6 to 8 ounces (180.0–240.0) of wine, with 4 or 5 ounces (120.0–150.0) of water (Yeo).

CARDIAC ANEURYSM

(Aneurysm of the Heart)

A cardiac aneurysm may involve either the whole diameter of the myocardium (aneurysm of the walls),¹ or merely the valves, together with a few myocardial fibers. Aneurysmal dilatation of the coronaries due to sclerosis or embolism is also recognized.

Aneurysm of the Walls.—This is not of frequent occurrence. Its most common seat is the wall of the left ventricle near the apex; it is quite generally a sequel to chronic myocarditis, which occurs oftenest at this point. In size cardiac aneurysms are exceedingly variable, and may either be very small or as large as the average-sized head of an adult. As to form, two types should be recognized: (a) an equable dilatation of a part of the ventricular wall, and (b) the sacculated form. Layers of fibrin are often found in these aneurysmal dilatations—an indication of Nature's attempt at a cure, and occasionally she is successful. Once an aneurysmal distention has begun, a straining effort may cause sudden increase of its dimensions or rupture it. The structures adjacent to the aneurysm exhibit fibrous overgrowth. This condition may rarely be congenital. Males are more commonly affected (74 per cent.—Hare).

Diagnosis.—Aneurysm of the myocardium has no characteristic features. Usually the *symptoms* and *local signs* of chronic myocarditis or dilatation are more or less conspicuous, but the presence of the aneurysm is not even suspected unless certain physical signs develop. These are: a *pulsating prominence* in the apex region that may even perforate the chest-wall, and a *coextensive dulness*. The abnormal area of dulness, which is peculiarly circumscribed, is best appreciated early by stethoscopic percussion. An aneurysmal dilatation may also be confirmed by the roentgen rays or the orthodiagram. The *course* of these cases is unfavorable, death ensuing (rarely) from rupture of the sac or (more frequently) from gradual cardiac exhaustion.

Valvular aneurysms sometimes arise in acute ulcerative endocarditis, which destroys the segmented endocardium and permits of dilatation as the result of the intracardial blood-pressure. They occur with much greater frequency on the aortic than on the mitral valves. They are spheroid in shape, and project into the left ventricle when found at the aortic segments, and into the left auricle when at the mitral. Rupture of these aneurysms is common, with the subsequent development of valvular incompetency. They cannot be *diagnosed* during life.

RUPTURE OF THE HEART

This rare and serious accident may either be *complete* or *partial*. The term "partial rupture" implies laceration of the trabeculæ ventriculi, whereby the chordæ are liberated. Rarely, the papillary muscles are torn, causing valvular incompetency. Complete rupture consists in a solution of continuity of the total diameter of the myocardium.

Pathology.—The chief seat of rupture is the anterior wall of the left ventricle, though it may also occur in the right ventricle and in the auricles. The rent runs parallel with the muscular fibers, and is to a certain extent the result of laceration, although chiefly of a separation, of the fibers. The fissural communication presents irregular edges, and at autopsy is seen to contain

¹ Of 87 cases collected by Pelvet, 57 were in this situation, and of 90 collected by Legg, 59.

more minute portions, becoming released, may give rise to embolism in distant parts.

(b) PARASITES.—Four forms may invade the heart muscle—the *Tænia echinococcus*, actinomyces, *Cysticercus cellulosæ*, and the *Pentastomum denticulatum*. The former two only are productive of mischievous results. The echinococcus growths may attain to considerable dimensions and are often multiple; they are secondary to echinococcus cysts in other organs. Their effects are produced in a purely mechanical manner unless fragments become detached, when they may excite embolic lesions at different points in remote organs.

(c) MISPLACEMENT (*Transposition of the Heart*).—During intra-uterine life the heart (and rarely all the other thoracic and abdominal viscera) may either be transposed to the right side of the thorax, or the fetal position—in the median line—may be retained. The sternum may be missing in whole or in part, and the heart, which now lies immediately beneath the skin, can be seen and felt as a throbbing tumor. Recently an apparently healthy man of about forty years applied at the Medico-Chirurgical Hospital in whom the lower half of the sternum was absent; his heart occupied a position in the median line directly underneath the skin.

Very exceptionally other anomalous positions are acquired during antenatal development, and the heart may become displaced upward in the chest cavity even to the neck or downward into the abdominal cavity.

(d) FLOATING HEART.—The structures that serve to maintain the heart in its normal anatomic relations may become weakened and unduly lax, in consequence of which the organ may exhibit increased motility.

III. NEUROSES OF THE HEART

PALPITATION

Definition.—A more or less rapid action of the heart that is perceptible to the patient, and usually accompanied by an increased force of the cardiac contractions or a disturbance of the rhythm, including extrasystole (*vide infra*), and often also by precordial distress, anxiety, and dyspnea.

Etiology.—Chronic valve disease and other organic affections of the heart seldom produce palpitation. Among predisposing causes are: (1) Mental excitement, depression or emotion. (2) Anemia (from the local irritant action of the altered blood state). (3) The acute infectious diseases, in which the toxins in the blood irritate the cardiac accelerating nerves. (4) Dyspepsia, even in robust-appearing persons (as in the gouty) who wittingly or unwittingly commit dietetic errors. Special articles of diet may excite overaction (*e. g.*, strawberries, shell-fish), the palpitation thus arising from reflex irritation being dependent upon gastric catarrh. (5) The use and, more especially, the abuse of tea, coffee, alcohol, and tobacco. (6) The female sex manifests a greater disposition to the complaint than the male, especially about the period of puberty and the menopause. In the male it is most common at or after the middle period of life, a time when the effect of the work and worry of life show themselves. (7) Disturbances of the pelvic organs may possibly induce palpitation reflexly.

Symptomatology.—Cardiac overaction, as a rule, displays a definitely *paroxysmal* character. The *onset* is sudden, and immediately preceding the

(2) *To prevent a recurrence of the paroxysms*, the causal conditions, some of which may long antedate the occurrence of palpitation, must be removed, if this be possible. All exciting factors must also be avoided. When cardiac palpitation occurs in neurasthenia and hysteria the Weir-Mitchell rest-cure should be advised. If the heart be weak, digitalis may be exhibited. I have observed good effects from the use of baths (carbonated).

TACHYCARDIA

(*Synchopexia; Rapid Heart*)

Definition.—A rapid movement of the heart directly dependent upon either paralysis of the pneumogastric, stimulation of the sympathetic nerves, or disease of the heart. Martius believes that the condition is attributable to sudden dilatation. Gordon¹ claims that tachycardia may be determined by dilatation of the splanchnic area, diminishing greatly the supply of blood to the left ventricle.

Pathology and Etiology.—It occurs as a physiologic condition in certain individuals; in such cases the pulse may range from 90 to 100 beats per minute or over. Certain persons can increase the pulse-rate by their own volition. The following table, modified from Mackenzie, indicates the various conditions which may be associated with a continuously rhythmic rapid heart rate:

(1) *Valvular Disease.*—A rapid heart rate associated with valvular lesions is usually an indication of failing muscle.

(2) *Myocardial Disorders.*—Weakness of the heart wall is usually first shown by a tachycardia, which may be induced by physical effort only and which is out of all proportion to the amount of work.

(3) *Exogenous Toxins.*—These include alcohol, arsenic, tea, coffee, tobacco, and the products of bacterial infection notably.

(4) *Endogenous Toxins.*—The toxic substance elaborated in the thyroid, an iodized protein, seems to have an almost specific stimulating effect on the cardiac accelerators of the sympathetic system.

(5) *Neurotic Conditions.*—The causes of this variety are identical with many of those that excite palpitation. Thus, among disposing factors are hysteria, anemia, neurasthenia. Violent exercise, intense mental agitation, fright, pain, grief, and other forms of shock are determining influences. Not a few cases are met at or about the menopause.

(6) *Lesions of the Nervous System.*—The lesions that induce this form are: (a) *central* and (b) *peripheral*. In the former group are especially to be placed tumors, clots (due to hemorrhage), and softening of the medulla and cord; and in the latter, tumors, aneurysms, enlarged lymph-glands (which paralyze the vagus by exerting pressure upon it either in the neck or thorax), and neuritis, affecting the pneumogastric nerve. The latter lesion may be associated with polyneuritis (alcoholic or infectious).

(7) *Exhausting Diseases.*—Cancer, severe anemia, and other wasting diseases are accompanied by rapid pulse-rate.

(8) *Hemorrhage* if at all severe produces tachycardia probably as a result of the loss in blood mass at first, later as a result of nutritive changes in the heart and nervous system.

(9) *Pregnancy* is associated with tachycardia.

¹ *Brit Med. Jour.*, March 12, 1910.

BRADYCARDIA

(Brachycardia)

Definition.—Slowness of the pulse. The condition may be physiologic, the rate of the pulse being sometimes 60 or less, and very rarely as low as 40 per minute during perfect health.

All cases of pathologic bradycardia fall naturally and conveniently into two groups: (1) those that are secondary to other complaints (*symptomatic bradycardia*), and (2) those that are due to neurosis.

Pathology and Etiology.—**Symptomatic Bradycardia.**—(a) Arising during convalescence from acute infectious diseases, especially *pneumonia*, *typhoid*, *diphtheria*, *influenza*, and *acute rheumatism*. According to Riegel, who analyzed 1047 cases, the *acute fevers* must be awarded the first place among the causal factors. I have met 3 cases of diphtheria in which the pulse fell to 30 a minute. That such instances are, as Traube contends, due to exhaustion is true of some cases, but not of all. The slowing of the pulse that is observed after premature or full-time delivery is similarly produced. (b) The second place belongs easily to gastro-intestinal and hepatic disorders (*chronic gastro-intestinal catarrh*, *ulcer*, or *carcinoma of the stomach*). (c) Bradycardia occurs in diseases of the circulatory system—in *coronary disease*, fibroid and fatty myocardial change, most frequently; and chronic valvular disease much less frequently, if we except aortic stenosis. It generally occurs with heart-block, whether organic, or functional, or from digitalis. In extrasystoles the premature contraction of the ventricle may be too weak to cause arterial pulsation. Some cases of auricular fibrillation show a slow pulse for the same reason or because of digitalis therapy. (d) Pulmonary complaints (emphysema and asthma). (e) Toxic agencies, as in jaundice, blood-poisoning, alcoholism, the unwonted use of tea, coffee, tobacco, and a few drugs (*e. g.*, coal-tar drugs). (f) Constitutional affections (anemia, chlorosis, gout, diabetes). (g) Rarely skin diseases and affections of the sexual organs, various grades of hypothyroidism, and commonly myxedema, are associated with bradycardia. (h) In various organic nerve affections (apoplexy, meningitis, epilepsy, tumors of the cerebrum and the medulla, injuries, and diseases of the cervical portion of the cord). Among soldiers in the trenches Binet's studies show that wounds of the skull and of the chest, when the heart is affected, cause bradycardia. Bradycardia is produced by direct or reflex irritation of the center or peripheral portion of the vagus except in cases in which it is brought about by exhaustion of the automatic motor apparatus of the heart. The condition is more common in men.

DISORDERED ACTION OF THE HEART

(Effort Syndrome, Neurocirculatory Asthenia, Irritable Heart of Soldiers)

Historical.—This condition, so carefully described by Da Costa in 1871, has been very extensively studied by the British, under Lewis' direction, and by the Americans, chiefly under Peabody in the United States, and Cohn in the A. E. F. These elaborate and careful studies were carried out because of the large number of soldiers invalided home by the British in the early years of the war on account of rather vague cardiac symptoms which were sufficiently severe to prevent the men carrying out their duties as soldiers. The United States, profiting by the lesson that the British had learned, under the guidance of the late Dr. Janeway, attempted, as far as possible, to seek out these cases

in the recruits and to hold them, when found, at home to perform lighter duties than would be required in the A. E. F. By this method it was hoped that men who were unfit for combat service would not be sent overseas to be invalided home at a later period when they had broken down under the strain of warfare. In spite of the careful examinations made by special boards of cardiovascular experts, many of these men did reach France, subsequently to break down. It was these cases that were later studied from many angles by Peabody and his co-workers at Lakewood General Hospital.

Pathogenesis and Etiology.—Among the British the general feeling for a time was that the condition depended upon some change in the myocardium, whether dependent upon a present acute infection or upon the changes produced by a previous acute infection. In the United States, although there are some observers who believe the condition is dependent upon thyroid malfunction, chronic disease of the heart, or an acute infection process, the general consensus of opinion here and probably in England also at the present time, is that the condition is simply a cardiac manifestation of the war neuroses. Given a soldier constitutionally and physically inferior, sooner or later under the stress and strain of war conditions he was likely to develop a neurosis of some type. This neurosis in many soldiers was that of the type described as disordered action of the heart.

Symptoms.—The symptoms may appear in the constitutionally predisposed upon first entering the army. In the more hardy they made their appearance only after actual combat had been engaged in. Such soldiers complain of dyspnea upon slight exertion, and oftentimes nocturnal dyspnea; pains over the precordium and referred down the arms are common, especially after effort. They become tired upon slight exertion and frequently dizzy. In addition to these symptoms there may be numerous diverse and disjointed complaints.

Examination.—The patient has a characteristically worried and anxious look. There is usually a well-marked coarse tremor of the hands, and even, in severe cases, generalized tremors. The hands are usually moist and the patient sweats profusely without adequate cause. Precordial areas of hyperesthesia are common. The heart shows little change, if any, in size and murmurs are practically always functional in character, if present. Tachycardia, however, is generally pronounced and the rate of the heart is unduly raised by exercise, generally failing to return to the previous rate two minutes after exercise. Respirations are rapid also. The tendon reflexes are exaggerated, whereas corneal and palatal reflexes are absent. Functional gastric disorders are common, but there is no evidence of organic disease (Musser¹).

Very briefly the above description applies to affected soldiers, but it should not be forgotten that similar symptoms and findings may be observed in civil practice in patients who have undergone severe physic strain or shock. Furthermore, it has been pointed out that the individuals predisposed to the fear neurosis usually and characteristically seek such employment or so guide their lives that danger, strain, and so on are reduced to a minimum.

Prognosis and Treatment.—Remove the exciting cause, and in the great majority of cases the symptoms will disappear. Cohn² very graphically relates how immediate and rapid was the disappearance of these cases in the A. E. F. following the signing of the Armistice.

¹ *Amer. Jour. Med. Sci.*, 1918, clv, 883.

² *Ibid.*, 1919, clviii, 453.

ough sometimes a cyclic irregularity is observed—*i. e.*, every second, fourth, sixth, or eighth beat being an extrasystole. To explain the premature contractions that arise in the ventricle it must be remembered that the ventricle contracts as a result of stimuli from the auricle. If an impulse arises in the ventricle a premature contraction occurs, which is followed by a long pause. As explained by Engelmann, this long pause is a consequence of the premature contraction, the ventricle being still in the refractory stage (lacking excitability) when the next physiologic stimulus reaches it, and it is not until the following stimulus arrives that contraction can again be produced. On the other hand, premature contractions arising in the auricle are followed by ventricular responses, as this ventricle always responds to auricular contractions placed in series. The auricular extrasystole is followed by a pause which plus the preceding beat is, however, not equivalent to two full cycles of the normal rhythm as is the ventricular extrasystole with its preceding beat (period of disturbance).

The various forms of arrhythmia described below are due to the occurrence of these extrasystoles. (b) Twin pulse (coupled beats, *allorhythmia*). When two beats follow each other quickly (the diastole being shortened), and the next two not so quickly (the diastole being lengthened), we have produced the *pulsus bigeminus*. The first and second beats may be of equal strength, but often the second is relatively feeble. This is best determined by auscultation of the heart, since the second systolic contraction (of the ventricle) may, indeed, be so weak as not to give rise to a palpable beat at the wrist. I have frequently observed the *pulsus bigeminus* in mitral disease. With respect to the diastole, the approximated pulsations may be in blocks of three (*pulsus trigeminus*) or even of four (*pulsus quadrigeminus*).

Etiology.—Baumgarten's classification of the causes of extrasystoles (quoted by Osler) is the best, and is here given:

(1) Those due to central—cerebral—causes, either organic disease, as in hemorrhage or concussion, or, more commonly, psychical influences.

(2) Reflex influences, such as produce the cardiac irregularity in dyspepsia and diseases of the liver, lungs, and kidneys. Fatigue in those predisposed.

(3) Toxic influences. Tobacco, coffee, and tea are common causes. Various drugs, as digitalis, belladonna, and aconite, may induce it.

(4) Changes in the heart itself. (a) In the cardiac ganglia. Fatty, pigmented, and sclerotic changes have been described in cases of this sort.

(b) Mural changes are common in conditions of this kind. Simple dilatation, fatty degeneration, and sclerosis are most commonly present. In every case of extrasystole, no matter what the cause, reflex or otherwise, there must, of necessity, be some pathologic lesion in the heart or its nervous mechanism.

A high blood-pressure may be associated with extrasystoles.

Excluding sinus arrhythmia, about 40 per cent. of the cardiac irregularities are caused by extrasystoles.

Symptoms.—Extrasystolic arrhythmia, particularly when functional or of reflex origin, may exist for many years. Symptoms referable to the heart may be absent, although in some instances the extrasystole causes a thud to be experienced, or the feeling as if the heart "had turned over"; a feeling of emptiness in the region of the pericardium sometimes follows the long pause of the ventricular extrasystoles.

Diagnosis.—Palpation and auscultation of the heart while examining the pulse are matters that should never be neglected if reliable results are to be obtained. A strip of tracing from the radial artery will suffice to show whether the extrasystole is auricular or ventricular in origin by measuring the distance between the beat preceding the premature combination and the end of the ex-

Etiology.—Lewis' analysis of 126 cases showed an antecedent history of either rheumatism or chorea in 70 per cent. Among non-rheumatic subjects it was more frequent in males than females, and was commonest in advanced life. In the rheumatic type the vast majority of patients are from twenty to fifty years of age. Of Lewis' series of fibrillating cases, 52 per cent. presented mitral stenosis. Other cardiovascular conditions with which fibrillation is associated are mitral regurgitation, aortic disease (rare), myocarditis, and interstitial nephritis.

Auricular fibrillation constitutes over 40 per cent. of the various arhythmias seen in a general medical ward.

Symptoms and Diagnosis.—In general, the ventricular rate varies from 100 to 160. With normal conduction the rate may reach 200 or over (delirium cordis), while impairment of this function may reduce it to 40 or even less. An accurate diagnosis requires the use of the electrocardiograph. Graphic curves, both arterial and venous, show an irregular succession of strong and weak contractions. The ventricular form of venous pulse is present, and is also found in tricuspid regurgitation.

Auricular fibrillation is usually recognizable by clinical observation. The pulse is rapid, usually over 120 per minute, and absolutely irregular in force, rate, and volume. The irregularity of rate and force is best appreciated by the stethoscope at the apex. The successive pulse-waves are so irregular that it is impossible to draw any definite conclusion as to the blood-pressure. Various methods (*e. g.*, Janeway's average pressure; pulse deficit method) of taking the blood-pressure have been recommended to secure information of functional ability of the heart. The associated phenomena and cardiovascular lesions, often grave and indicating cardiac failure, are of great diagnostic import.

From other forms of arhythmia, such as extrasystoles and partial heart-block, auricular fibrillation is distinguishable by its greater persistence, by the effect of exercise, which increases the irregularity of the latter while it tends to remove that of the former. Similarly, drugs of the belladonna group aggravate fibrillation and diminish partial functional heart-block. The presystolic murmur of mitral stenosis generally vanishes in auricular fibrillation, but not invariably (Talley).

Prognosis.—This depends upon the associated conditions, the ventricular rate (the slower the rate, the better the prognosis), and the response to treatment. If the patient is willing not to make any unwonted exertion, a guardedly favorable prognosis is permissible in many cases. Musser, on the other hand, has studied a case in whom the fibrillation apparently persisted for twenty years. Forty-eight per cent. of the cases of auricular fibrillation followed by White¹ for two or three years have died.

Treatment.—Rest is an important item of treatment. Digitalis acts most satisfactorily. It is in this condition that Mackenzie says it acts almost as a specific, and that as a result of the splendid results achieved from its use digitalis has secured the reputation it enjoys in the treatment of cardiac conditions. It acts by producing a block in the bundle of His which checks the numerous ventricular stimuli from the auricle. On the other hand, in cases of advanced myocardial degeneration this drug may fail. The rate of the pulse serves as a guide to its administration, and when normal again for the individual it should be discontinued. Canby Robinson² advocates giving digitalis in a single large dose, 15 c.c. of the tincture per 100 pounds. The effect of the drug upon the heart is first manifest in from two to four hours; the drug attains its

¹ *Amer. Jour. Med. Sci.*, 1919, clvii, 5.

² *Ibid.*, 1920, clix, 121.

the condition in man; he showed that constriction of the circular layer of muscle at the auriculoventricular junction in the heart of tortoises causes a cessation of the rhythmic action of the heart so that the auricles and ventricles become independent in their contractions, the former beating more rapidly than the latter. The impulse in the human subject flows through a bundle of neuromuscular tissue extending from the right side of the interauricular septum to the interventricular septum just below the *pars membranacea*; it is approximately 18 mm. long, 2 mm. broad, and 1.5 mm. thick. Now, if this pathway for the impulse is blocked the phenomena of Adams-Stokes disease may be produced. Erlanger has been able to gradually compress the bundle of His and bring about varying degrees of heart-block: *e. g.*, at first there occurs an occasional failure of ventricular contraction, then a ratio of auricular to ventricular beats of 2 to 1, 3 to 1, 4 to 1 (partial block), and finally complete block when the ventricles contract slowly and independently of the auricular rhythm. On the other hand, mild cases of partial block exist in which there is simply a delay in transmission of the auricular impulse through His' bundle to the ventricle (delayed conduction time—prolonged *a-v* interval).

Various *pathologic changes* in the bundle of His have been found post-mortem, thus confirming the results of physiologic experiment. For example, Stengel found an atheromatous patch over the bundle of His; Ashton, Norris and Laveson, and others a gummatous involvement of this structure, while Walter James¹ noted recent ulceration. *Temporary and incomplete heart-block* has been noted in certain acute infectious (typhoid fever, diphtheria, influenza, pneumonia, and others) and in the fibroid heart. It may also follow the prolonged use of digitalis.

Other Types of Heart-block.—*Sino-atrial block* is a type of heart-block in which the impulse, arising in the sinus, is either blocked within the sinus node or between the node and the atrial musculature. It may be recognized clinically by the dropping of a complete beat, but as an apparent dropping of a beat may be due to other causes, *e. g.*, extrasystoles, it can only be recognized accurately by the electrocardiogram. *Arborization block* represents a type of block in which there are abnormal deviations of the Q, R, S complex in the electrocardiogram. The cause is either due to impulse transmission through circuitous and aberrant paths or to delayed transmission through normal channels (Willius²). It is a prognostic sign of ill import. Endocarditis is the most frequent causative disorder.

Bundle branch block is recognized only by the electrocardiograph and is a condition in which conduction through one or the other branch of the bundle of His is delayed. Delay in the right branch results in an electrocardiogram resembling left ventricular hypertrophy; in the left branch, of right ventricular hypertrophy.

Symptoms.—The important features are: (a) Bradycardia, (b) visible auricular pulsation of the cervical veins, and (c) cerebral attacks.

(a) Bradycardia—the slow pulse is a persistent feature in most cases, but it may be paroxysmal. The rate falls to 40, 30, 20, or even less beats per minute, and it often bears a definite relation to the normal for the sufferer. The pulse is scarcely influenced by exercise or drugs that quicken the heart action. Arrhythmia of the ventricular contractions may be noted, but is not common.

(b) We often observe a 2 to 1 or 3 to 1 rhythm on comparing the auricular impulses as noted in the veins of the neck with the ventricular systole. This is due to the fact that most of the former fail to cross the bundle of His. Feeble

¹ *Amer. Jour. Med. Sci.*, October, 1908.

² *Arch. Int. Med.*, 1919, xxiii, 431.

auricular sounds may be heard, when the ventricle is in systole. The blood-pressure is notably increased (De Renzi).

(c) The cerebral attacks consist principally of vertigo, which is usually momentary, syncope, rarely convulsive seizures, and pseudo-apoplectiform attacks. The attacks of unconsciousness may prove fatal. Heart-block is not necessarily associated with Stokes-Adams' phenomena (syncopal attacks). On the contrary, most cases of heart-block do not have the seizures. Wilson and Robinson¹ report a case of heart-block in which they were able to show by electrocardiographs taken during the syncopal attack that the attack was due to ventricular standstill lasting from seven to eleven seconds.

Diagnosis.—*Bradycardia* must be distinguished from Adams-Stokes disease. The former is characterized by a pulse below 48 beats per minute, with corresponding slowness of the systole and the auricular impulse, and it has a different etiology (*vide ante*). Doubtless, atypical cases of the Adams-Stokes syndrome occur, due to slight degenerative changes in the bundle of His, and these may exist for years before the clinical picture becomes typical. Krumbhaar reports a case of transient attacks of heart-block in which the right branch of the bundle of His was found completely obliterated; this condition alternated with normal pulse. There are instances in which the bundle of His shows no pathologic changes (Edes and Councilman).

Recurring extrasystole, simulating heart-block, may be due to hyper-rhythmicity of the atrioventricular bundle and not due to blocking of this stricture (*functional variety*). Here there occurs a forcible venous pulsation in the neck "without either a radial pulse or a discoverable pulsation in the innominate artery" (James). Seven cases have been recorded in the literature.² Clarac and Pezzi invite attention to contraction of the auricle coincidently with the first part of the contraction of the ventricle, causing a explosive first sound, which testifies to total heart-block if the ventricle beat is regular.

The **prognosis** is grave in cases showing persistent heart-block of high grade. In young patients, whose heart muscle is functionally efficient, the prognosis is usually good. The functional form gives a favorable prognosis.

Treatment.—This consists in rest in bed and in overcoming the feeble condition of the circulation by free stimulation. In cases presumably due to syphilis, the iodids in massive doses should be given. In the functional form, atropin changes the ratio between auricular and ventricular beat, so as to cause the heart-block to disappear. During the syncopal attacks but little can be done for the patient, though nearly every type of drug which has any effect on the heart, directly or indirectly, has been recommended.

PAROXYSMAL TACHYCARDIA

Definition.—A condition characterized by the abrupt onset of extremely rapid heart rate as a result of "new, rhythmic, and pathologic impulses" (Th. Lewis).

Pathology and Etiology.—In the few cases that have come to autopsy, fibrosis of the heart wall has been the most frequent finding. Nerve lesions have been found at times, but it is questionable if they have had any direct association with the condition. In regard to etiology, males are more frequently affected than females. The condition may occur in any decade of life after the first. Rheumatic fever occasionally is noted in the history of these patients, and at times mitral stenosis or myocardial degeneration is associated with it.

¹ *Arch. Int. Med.*, 1918, xxi, 183.

² See Pepper and Austin, *Amer Jour. Med. Sci.*, May, 1912, p. 716.

Paroxysmal tachycardia is produced in the following manner: Normally, rhythmic impulses arise at the so-called "pace-maker" of the heart, located at the junction of the superior vena cava and the right auricle. At times an abnormal focus of impulse formation arises in the heart wall, usually the auricle, from which rhythmic impulses are sent out at a more rapid rate than the usual pace-maker rate, and which "dominate the movements of the whole heart." Lewis says they may be regarded as a regular series of premature beats. As a result of these new formed impulses there is a sudden and marked increase in the heart rate. Vaughan has shown that the site of impulse formation may be rarely in the ventricles (ventricular hyperirritability).

Symptoms.—The clinical picture in most instances of the complaint is made up of recurring paroxysms of heart hurry. These attacks may come suddenly without prodromes. If the latter occur, they consist of vertigo, tinnitus, a sense of impending danger, and sometimes a "heart-flop" due to extrasystole. The "flop," however, more commonly ends the paroxysm. With the onset of the paroxysms the *cardiac movements* leap to 150, 175, 200, and 250, or even to 300 beats per minute. The *pulse* is feeble, small, readily compressible, as a rule, and sometimes irregular. Rarely it is full, strong, and of good tension. The *respiration* may or may not be increased in frequency, but dyspnea is not common. At first pale, the *skin* soon becomes flushed, and the *countenance* may wear an anxious expression; but unless "palpitation" is associated there are no symptoms present that denote an intense degree of suffering. In many cases the patient is not conscious of palpitation, or there may be a sense of slowing of the heart, when in reality the cardiac contractions may be increased to 200 or more; this is *typical tachycardia*. Gallavardin claims that the temperature is liable to be higher and the tachycardia more pronounced in the early morning than in the afternoon. In a chlorotic girl I found that the pulse-rate increased from the normal rate to 200 beats, and lasted for a few minutes at each visit to my office. H. C. Wood reports a case occurring in a physician eighty-six years of age, who has had attacks since his thirty-seventh year, the pulse rising quickly to 200 beats per minute.

Physical Signs.—A diffuse, rapid, and regular impulse may be observed on inspection and palpation, but seldom is there an enlargement of the heart. The *sounds* are slightly modified, the first being accentuated and the second aortic diminished in intensity, owing to the lessened amount of blood thrown into the aorta with each systole; the intensity of the second pulmonic, however, may be increased. An apical *systolic murmur* is occasionally audible. The carotids pulsate, and on ausculting over them a murmur is sometimes heard.

Diagnosis.—I would restate the fact that a high pulse-rate (200 or over a minute) and an absence or only a slight sense of palpitation or rapid heart action are the distinctive features of tachycardia. In *palpitation* (previously considered) the pulse-rate is not usually so high, while the associated phenomena of dyspnea, precordial constriction, smothering, and painful anxiety are correspondingly more pronounced.

Prognosis.—In the majority of cases no serious impairment of the general health follows, though the course is exceedingly chronic and recoveries are comparatively rare. At times death occurs during a paroxysm. The duration of tachycardia varies from one to two or more decades.

The **treatment** is to be conducted on the lines advanced for Palpitation (*vide* p. 674). Fairbrother has cut short the paroxysm in his own case by either walking or an exercise like a girl skipping the rope. An abdominal binder, with a view to emptying the splanchnic vessels, may reduce the excessive

The pain is due to acute dilatation of the heart. Heberden first made the observation that angina is essentially a vascular pain, and showed its extracardiac origin.

Etiology.—Cases of angina unassociated with *arterial sclerosis*, *hypertrophy*, *aortic regurgitation*, or adherent pericardium, are rarely encountered. With few exceptions sclerosis of the aorta and coronaries is present, and predisposes to the condition. This view receives some degree of color from the fact that angina usually occurs after the *fortieth year*, and principally in the *male sex*. Bramwell, however, analyzed 178 cases, and in 48, or 26.9 per cent., no definite lesions were detected either in the heart or aorta. Angina pectoris in the young should always suggest syphilis. Anders has collected 270 cases from the literature, of which 26.5 per cent. gave evidence of syphilis. These figures are much too low, as no mention is made of the Wassermann test in 250 of them, dependence being placed solely on the history. It may be a sequel of influenza. Dyspeptic disturbances may aggravate the disease. The *determining factors* of the attack are undue exertion and mental emotion.

Symptoms.—The *paroxysm* begins quite suddenly during the action of one or other exciting cause, and often during exercise after a heavy meal. There is excruciating pain of a grip-like character, affecting the entire chest and rendering the body motionless. The pain *radiates* most frequently to the left shoulder, though also to the right, and thence to the back, neck, and down the arms to the fingers. Not less agonizing than the pain is the awful sense of *impending death*. "The sense of constriction without pain occurring after the ordinary exciting causes of angina is always highly suggestive" (Herrick and Nuzum). *Coldness* and *numbness* of the fingers or in the precordial area may be present. The *countenance* is frequently pale, and may assume a leaden hue, and is usually bathed in cold perspiration. The *respirations* are shallow or even temporarily arrested, and the patient's anxiety is extreme. The *heart's action* may be regular, and the arterial tension is generally increased markedly, though in many cases the systolic pressure may be lowered or normal. The *duration* of the paroxysm varies from a few seconds to a minute or two (rarely it lasts for hours), and after the attack, which subsides suddenly, gaseous eructations, vomiting, or the discharge of a large amount of clear urine may occur. Cheyne-Stokes' breathing has been observed. After the seizure there may be an *absence of signs*, and, though there is weakness, this soon disappears. The attack may *recur* at intervals varying from a few days to as many years.

Varieties.—1. **Angina major**, or severe form, in which arterial disease is uniformly present. Its subvarieties are thus classified by Osler: (a) the fulminant or rapid form with one or two attacks only, or sometimes with the condition known as status anginosus; (b) the form with a duration of one and a half to two years and a varying number of attacks; (c) the chronic form, lasting upward of ten years with a varying number and growing intensity of attacks, that, for instance, of John Hunter, whose first seizure occurred twenty years before his death; and (d) lastly, the small group of cases which may last for months, or as long as two years, with attacks of great severity, and yet may completely recover.

2. **Angina minor**, or mild form, usually described as "false or pseudo-angina," with its subgroups, the neurotic, the vasomotor (Nothnagel), and the toxic forms. Mackenzie, among others, forcibly protests against this term, "pseudo-angina." He maintains that angina pectoris is an entity characterized chiefly by severe cardiac pain which is dependent upon lesion of the heart and blood-vessels; to term pain in the region of the heart unassociated with organic heart disease as pseudo-angina is but a confession of ignorance of the

obviate the action of the exciting causes, but also to overcome any predisposing influences that may exist. Prolonged rest in bed should be enjoined in true organic cases, and in those who cannot walk without pain. Excessive tobacco smoking must be discontinued. Schott prefers baths (effervescent) and passive movements to drugs or other methods. Passive movements alone should first be performed by an assistant, but later may be safely entrusted to the patient. In cases in which the arterial tension is habitually exalted, nitroglycerin in increasing doses is to be used perseveringly, beginning with $\mathfrak{m}\mathfrak{j}$ (0.065) and increasing by $\mathfrak{m}\mathfrak{j}$ (0.065) every five or six days until the physiologic effects are produced. Sodium nitrite may be employed alternately with the nitroglycerin, the dose being gr. j to $\mathfrak{i}\mathfrak{i}\mathfrak{j}$ (0.065–0.18) three or four times daily. Says Kohn,¹ to ward off attacks theobromin has fully established its efficacy. Romberg has urged the employment of digitalis. Recently a case has been seen in which the very frequent paroxysms of the patient were relieved by benzyl benzoate, 4 c.c. of the 20 per cent. emulsion every four hours. Marked arterial sclerosis, if there be a syphilitic history, is favorably influenced by a long course of potassium iodid. In cases in which there is quick recurrence, sodium nitrite in $2\frac{1}{2}$ -gr. tablets (dose, 1 to 4 tablets) is recommended. Allbutt lauds—(a) the high-frequency current, and (b) the administration of the lactic acid bacillus. When hypertrophy of the left ventricle is excessive, I use the following:

R. Sodii bromidi, $\mathfrak{z}\mathfrak{i}\mathfrak{v}$ (16.0);
 Tinct. aconiti, $\mathfrak{m}\mathfrak{l}$ (3.3);
 Elix. aromatici, q. s. ad. $\mathfrak{f}\mathfrak{z}\mathfrak{i}\mathfrak{i}\mathfrak{j}$ (90.0).—M.
 Sig. Teaspoonful in water after meals.

It may be omitted at the end of every two weeks for two or three days. Dyspeptic troubles should be rectified. For Cheyne-Stokes' breathing Allbutt advises the inhalation of oxygen and carbon dioxid alternately. Venesection may be employed in high arterial tension.

IV. CONGENITAL AFFECTIONS OF THE HEART

These result from two leading causes: (1) Arrested development, and (2) fetal endocarditis. Occasionally, both these factors are operative. It is not infrequently found in patients suffering from congenital syphilis, as evidenced by a positive Wassermann reaction.

(1) **Arrested development** may produce a great variety of anomalies: (a) *Acardia*, absence of the organ. (b) *Cor biloculare*, or *reptilian heart*, in which the septum between the auricles and ventricles is absent, thus reducing the number of chambers to two. (c) *Absence of the interventricular septum*, the heart consisting of three chambers (*cor triloculare*). (d) *Patency*, or *incomplete closure of the foramen ovale*. Persistence of the foramen is, in the majority of cases, associated with obstruction of the pulmonary valve, though it may be solitary. (e) An anomaly known as *ectopia cordis* deserves mention. The sternum is usually divided vertically, and the heart is either entirely exposed or beating just beneath the skin in the cardiac, thoracic, or abdominal

¹ *Berliner. klin. Wochen.*, May 17, 1915.

Differential Diagnosis.—

CONGENITAL LESIONS

History of almost constant cyanosis, beginning in the first week after birth.

Slight enlargement of the heart. It is the right ventricle and non-progressive.

Loud and musical murmurs present, audible over upper third of sternum, with small area of transmission upward and to the left; second sound weak.

Deficient bodily development.

Mental faculties in abeyance.

ACQUIRED LESIONS

Not so; history of endocarditis or of rheumatism or other complaints in which endocarditis occurs as a complication.

Enlargement marked, frequently involving the left ventricle, and progressive.

Audible over apex or base; definite large areas of transmission. Second sound frequently accentuated.

Bodily development good, as a rule.

Mental faculties normal.

The **prognosis** is exceedingly grave. Many succumb within a few days after birth, more than one-half before the expiration of one year, and not less than three-fourths before the end of the third year. Few survive the first decade of life, and fewer still reach full adolescence. The form giving the most favorable prognosis is pulmonary stenosis with defective septa. There is a disposition to affections of the lungs (phthisis), nerve complaints (convulsions).

The **treatment** is, in the main, hygienic. The body must be warmly clad. The diet is to be judiciously arranged, yet liberal. Gentle exercise, when it can be taken, is valuable, as are also daily spongings of the surface followed by friction. Special therapeutic indications may arise, and must be met in accordance with general principles.

clinical evidences of involvement of the aorta and heart almost never appear before the thirty-fifth year."

Symptoms.—The chief symptoms are *pain*, which may be either precordial or anginal in character; *dyspnea*, which may be induced by effort, or may be paroxysmal in character, coming out of an apparently clear sky and lasting for ten or fifteen minutes; and *palpitation*, which is noticed in a large majority of cases.

Physical Findings.—The area of dulness above the heart is increased and frequently there is episternal pulsation. A systolic murmur is usually heard, varying in intensity from a soft blow to a loud, rough, harsh murmur. When aortic insufficiency, the most frequent complication, is present, there are also the physical signs of this condition, and the same may be said of aortic aneurysm.

Diagnosis.—If, in addition to the positive Wassermann and aortic systolic murmur, roentgenologic examination shows a widening of the arch, the diagnosis is usually readily made. Specific aortitis is usually presumed to be present when there is aortic insufficiency, aortic aneurysm, or dilatation. Angina pectoris, the fourth important complication of the condition, is also assumed to be associated with syphilitic aortitis when the characteristic pains are present together with a systolic basal murmur heard best over the aortic cartilage, transmitted up the vessels of the neck, and a positive Wassermann test.

Prognosis.—According to Reed¹ the disease is of progressive character and of serious prognosis. Early diagnosis and intensively active treatment are necessary to prevent the complications of the disease progressing rapidly.

Treatment.—Vigorous antisyphilitic treatment is indicated in order to eradicate the spirochetes in the aorta. The treatment otherwise is symptomatic. Morphin at times is necessary for the relief of the pain. Benzyl benzoate has been successful in some cases in relieving this symptom.

ARTERIAL SCLEROSIS

(*Arteriosclerosis; Arteriocapillary Fibrosis; Endarteritis Chronica Deformans; Atheroma*)

Definition.—An atrophic degeneration of the median arterial coat followed by compensatory thickening (hyaline) of the intima.

Pathology.—The most frequent seat of the sclerotic process is the aorta, and the next most common the coronary arteries. Other vessels implicated are the arteries of the brain, the temporals, radials, brachials, ulnars, femorals, and iliacs. On the other hand, certain arteries, as the gastric, hepatic, and mesenteric, are rarely affected. Two forms may be recognized: (a) the circumscribed (atheroma) and (b) the diffuse. There is also a secondary variety due to hypertension, causing dilatation of the vessels, slowing of the current, and compensatory thickening of the intima.

(a) **Circumscribed Arteriosclerosis.**—Naturally, the intima presents a smooth internal surface, but when atheromatous changes occur it shows localized areas of thickening, often hemispheric in outline, yellowish-white in color, and their favorite seats are the orifices of the branches. They increase in depth and superficial area, and on reaching an advanced stage their interior disintegrates into granular material (*atheromatous abscess*).

Histologically, in circumscribed or nodular atheroma, the middle coat is the primary seat of the changes, which consist of localized infiltrations. These lesions weaken the media and then (as shown by Thoma) compensatory processes are set up in the intima and adventitia (Adami), which lead to the formation of the so-called *atheromatous button*. The latter consists in a hyperplasia

¹ Jour. Amer. Med. Assoc., 1919, lxxiii, 1832.

(b) **Pulmonary atheroma** is considered in its clinical relations in connection with the diseases of the heart and lungs.

(c) The **renal type** includes those instances of kidney lesion that are associated with, precede, or follow general arteriosclerosis. The condition is essentially an atrophic nephritis due to the diminution of the blood-supply to the organs in consequence of the narrowed lumen of the renal arteries.

(d) In this *type* the peripheral arteries become obliterated and cause starvation of the tissue, with resulting cramps and even gangrene.

Diagnosis.—Hardened arteries, increased arterial tension, left ventricular hypertrophy, and marked accentuation of the aortic second sound form a group of clinical characters that leaves no doubt as to the diagnosis. It may be the occurrence of apoplexy, acute cardiac dilatation, or of some other such accident that leads to the discovery of general arteriosclerosis. Slight albuminuria is generally present. A murmur may be heard over the base. An ophthalmoscopic examination is of the utmost value as a diagnostic aid, showing sclerosis of the retinal vessels. In young subjects the finding of a positive Wassermann is an important diagnostic aid.

C. Beck and others have found that the roentgen rays are useful in determining the extent of arteriosclerosis (*e. g.*, whether local or general).

To **differentiate** the murmurs of dilatation of the left ventricle following the hypertrophy of this disease from *organic mitral lesions* is only possible by the history or the results of treatment. In *aortic stenosis* the second sound is weak and the pulse less voluminous than in arteriosclerosis (*vide Aortic Stenosis*).

Essential hypertension, a condition which usually results in severe cerebral, cardiac, or renal lesions, is characterized by the presence of a single symptom, hypertension, for an indefinite period of time. Cases of persistent hypertension in middle-aged men in active business, given to the pleasures of the table and excesses in alcohol and tobacco, in my experience, yield to treatment, prolonged rest, and correction of the habits of the patient, and hence should not be classified as belonging to this clinical group of true hypertension.

Prognosis.—Arterio-capillary fibrosis is an exceedingly chronic, though usually a progressive, disease, and frequently it terminates life. The axiom that a man is as old as his arteries has been borne out by the test of extensive clinical observation. However extensive, sclerosis of the larger vessels has apparently little effect on decreasing longevity. The extent of kidney involvement has a very decided effect on prognosis, more so than any one other factor. Syphilitic arterial disease is usually of short duration as compared to other types, chiefly on account of the more serious arterial and other complications (aneurysm—aortic insufficiency). The condition may prove fatal either with great suddenness, as when it occasions apoplexy, or with unwonted slowness. Very rarely the aorta ruptures, causing instant death. Neither the systolic nor the diastolic blood-pressure gives any certain indication as to the condition of the cardiovascular-renal system as such; and when changes in the vascular system are accompanied by hypertension both conditions may be dependent upon “the presence of unexcreted toxic products of metabolism in the circulating blood” (Dana).

Treatment.—Though the progress of the disease cannot in most instances be successfully stayed, it can be retarded frequently by correcting aggravating habits and by removing the influence of ascertainable causes. The syphilitic taint, if present, requires the liberal use of the iodids and the careful use of mercury and salvarsan.

ANEURYSM

Definition.—A true aneurysm is a circumscribed dilatation of an artery, ~~med~~ of one or more of its coats.

Classified according to their form, aneurysms are—(1) sacculated, (2) ~~kindric~~, and (3) fusiform. They are termed *axial* when the complete circumference of the vessel participates in this dilatation; and *peripheral* when a ~~ngle~~ sac is confined to the side of the vascular duct.

Miliary aneurysms occur along the course of the cerebral vessels. On the other hand, aneurysms may attain the size of the human skull.

By a *false* aneurysm is meant one in which the coats are ruptured.

A *dissecting* aneurysm is one that, owing to laceration of the internal coat, ~~dissects~~ between the layers of the vessel wall. For its *seat* it usually selects the aorta, and may traverse its entire length.

An *arteriovenous* aneurysm arises from a direct fistulous connection between an artery and a vein (*aneurysmal varix*), or an aneurysmal sac may intervene (*varicose aneurysm*).

Pathology and Pathogenesis.—The wall of the aneurysm is commonly the seat of arteriosclerosis, which Malkoff claims is a compensatory arrangement. Osler states that the origin of aortic aneurysm is to be traced to mesaortitis, so different from chronic aortic degeneration. The common atheromatous disease does not often produce aneurysm. Extreme atrophy of both the intima and media is not uncommon in the later stages, the wall of the sac being formed chiefly by the adventitia. The intima (as in Daland's case of aortic aneurysm, in which there were both an old and a new transverse rent) may become lacerated, and finally the media and adventitia tear; this results in rupture unless the adherent neighboring structures compensate for the natural wall.

The blood in the aneurysmal sac is composed of old and new thrombi. The latter when comparatively recent may be soft, and when old may be firm or even calcified, yellowish in color, and adherent to the wall.

Etiology.—Among recognized *causes* are: (1) **Arteriosclerosis.**—Some of the conditions that originate the latter at all events also tend to bring about aneurysms. According to Rasch, syphilis was present in 56 per cent. of 25 aneurysms of the aorta discovered in the course of 3165 necropsies at Copenhagen, and Annsperger found it in 48.6 per cent. of 37 cases. Heller has found 85 per cent. of aneurysms due to syphilis. Since the advent of the Wassermann reaction more and more is syphilis being recognized as the one outstanding etiologic factor, so that at the present time there are some who teach that syphilis is the cause of all non-traumatic aneurysms. In a series of 621 cases, 58.5 per cent. were of luetic origin. In view of the fact that some of these cases had not been submitted to the Wassermann test, this percentage is too low. (2) **Sudden Great Strain.**—This may be productive of aneurysm, particularly in an artery weakened by pathologic changes such as are induced by syphilis. Thus may the fact be accounted for that most instances of aneurysm occur during the period of greatest bodily activity in the male sex. (3) **Embotic plugging of a vessel**, if complete, may cause aneurysmal dilatation on the proximal side of the point of obstruction. The development of aneurysm may be facilitated by the mechanical efforts of the embolus, which may be of calcareous hardness, as when it comes from diseased heart valves. Infectious emboli set up inflammation and softening. (4) **Mycotic Aneurysms.**—That aneurysms sometimes owe their existence to mycotic origin was first pointed out by Osler, who found an abundant growth of micrococci in the aneurysmal sacs. They are met with in ulcerative endocarditis, and are often small and

tetor, compression of the spinal cord may ensue, and is an intensely painful process. Pressure may be made upon the esophagus, causing *dysphagia*, or upon the left bronchus, causing *bronchiectasis*, with its usual *sequelæ* (bronchorrhea, fetid bronchitis, gangrene of the lung).

The sac may, in consequence of the slow ulcerative process that attends its progress, *rupture* (*vide* Prognosis). Frequently repeated small *hemorrhages*, due to weepings from the thinned walls, may precede the fatal rupture. I saw a case of aneurysm of the transverse portion in which rupture into the esophagus resulted, with instantaneous death.

When the tumor has reached the subcutaneous tissue and bulges externally, the skin covering it becomes tense and shining, and with increased pressure the surface becomes reddened and finally necrotic. The necrosed area is covered with a dry brown scab, which later is thrown off, leaving an oozing surface. Rupture soon follows.

Fig. 51.—Aneurysm of aorta.

Leading Symptoms in Detail.—Among these *pain* stands primarily, being the first and most constant. It is of two kinds: (a) due to direct pressure upon and stretching of the nerves. When aneurysm is developed suddenly, a sharp, excruciating pain is felt in the upper sternal region, accompanied by a feeling of "something giving way." In consequence of the stretching of the nerves a constant pain is experienced that is subject to exacerbations when the intra-aneurysmal pressure is raised. Pressure against the bony structures causes erosion, and usually produces a continuous boring pain. In a recent case of aneurysm shown in clinic at the Medico-Chirurgical College, however, a tumor of the size of a goose's egg had given rise to no suffering whatever (Fig. 51). In latent aneurysm there is an absence of pain. Anginose attacks sometimes occur when the sac has its seat near the heart. (b) Reflected pains of a neuralgic character may be excited by aneurysm. This is true, in particular, of aneurysms situated in the transverse portion of the aorta, in which instances pain is commonly felt in the region of the neck and occiput

frequent seat of the bulging—which varies in size from a hen's egg to a coconut—is over the first and second right interspaces near to, and frequently involving, a portion of the sternum; when seated just beyond the aortic orifice a pulsating prominence may occupy the third interspace along the left sternal border; situated in the transverse section of the aorta, bulging of the upper part of the sternum is common. In the descending portion the swelling, when present, is in the second and third left interspaces near the sternum, or in the left scapular zone. The apex-beat is displaced downward and outward, chiefly from pressure, though also from hypertrophy (functional).

Palpation.—The protrusion presents a more or less yielding and elastic mass, and when superficially seated fluctuation may be obtainable. The degree and the rhythmic expansile character of the pulsation are to be noted, and also the fact that there is an alternate contraction and dilatation of the sac in every direction—a distinctive feature.

If the aneurysm is largely concealed, bimanual palpation should be employed, the palm of one hand being placed over the spine and that of the other over the sternum. In rare cases aneurysmal pulsation is only yielded when the finger-tips are used, and especially at the end of expiration. A diastolic shock is often perceived, and forms a sign of no little value. A distinct systolic shock, sometimes accompanied by a purring fremitus, can also be felt over the aneurysmal sac.

Percussion.—If the growth be deep-seated, percussion may give negative results; when, however, the tumor causes bulging or comes in contact with chest wall, a proportionate area of flatness is presented. The abnormal field of dulness may be the only symptom present; it is the most frequent sign. Aneurysms of the ascending arch give flatness to the right of the sternum; those of the transverse arch, over the upper part of the sternum and to the left; while those of the descending portion are revealed by a flat area between the spine and the left scapula. With flatness of the percussion-note there is a sense of increased resistance. There is generally a moderate increase in the area of cardiac dulness. Conversely, the left ventricle has been found of diminished size at necropsy.

Auscultatory percussion (practised after the method of Sansom and Ewart) quite often gives valuable results.

Auscultation.—Since murmurs owe their origin, in great part, to the presence of fibrin in the sac, they may be absent, and this even in the case of large aneurysms. When, as is usual, a murmur is present, it is systolic in rhythm, heard with greatest intensity over the flat area or body of the tumor, and is transmitted in the direction of the blood-stream, being, therefore, distinctly audible in the vessels of the neck and along the course of the aorta. The murmur has a booming quality.

Aortic regurgitation may be considered as associated with aneurysm near the aortic ring when a double murmur is heard. In a few instances the diastolic bruit alone is detectable. A much intensified, low-toned second sound is present (unless marked aortic regurgitation coexists).

The Peripheral Arteries.—The pulse in the vessels beyond the aneurysm is delayed. Hence the two radial pulses may exhibit differences in time. The volume of the pulse beyond the aneurysm is lessened, and in aneurysm of the abdominal aorta or the femorals it may be obliterated. Such differences as these will not only point to the existence of thoracic aneurysm, but also its seat. Thus, if there be dilatation of the transverse arch with no implication of the innominate, the pulse at the right wrist is strong and almost simultaneous with the cardiac impulse, while that on the left side is small, weak, and delayed. If the reverse be true with respect to the pulse, then the aneu-

tors may duplicate all of the pressure-symptoms, though less apt to cause heaving, and less apt still to excite abnormal pulsation; when pulsation is noted it is quick, and not heaving and expansile, as in aneurysm. Solid growths do not lack the characteristic shock—both systolic and diastolic—of aneurysm. The cardiovascular symptoms are usually wanting in the case of solid tumors, especially the moderate hypertrophy, accentuation of the second sound, heaving, and the difference between the radial pulses.

Carcinoma of the mediastinum usually gives a history of the disease in other parts of the body, with enlargement of the axillary or other superficial lymphatic structures, and later the characteristic cachexia, this being particularly marked in a carcinoma of the esophagus.

Abnormal pulsation in the aorta is noted in neurotic subjects, mostly females, and in aortic regurgitation; less frequently it is associated with retraction of the right lung, with spinal curvature, and with displacement of the aorta. In the case of the latter two conditions a careful consideration of the causal states and the absence of the characteristic physical signs would lead to a correct diagnosis. *Aortic regurgitation* is frequently associated with aneurysm of the arch, and in its course there is often developed a dilatation of the ascending portion of the aorta. The diagnosis of aneurysm of the arch of the aorta should not be made, therefore, in these cases, unless the physical signs and symptoms be unmistakable. Dynamic pulsation of a neurotic origin is seen and felt in the episternal notch, as a rule, and a correct appreciation of the nervous element will prevent the observer from committing an error.

Pulsating empyema can only be confounded with large aneurysmal growths, and, as pointed out by Wilson, it does not have the same definite relation to the central long axis of the body as do aneurysms. The abnormal field of dullness is situated at the base of the lung in empyema, and is less circumscribed than in aneurysm. In empyema, moreover, the pulsation is not expansile, but is caused by pressure of the respiratory movements. Auscultation in empyema renders audible neither a bruit nor the double shock of aneurysm; the pressure-symptoms and pulse characters are also entirely wanting.

Pulmonary tuberculosis may be mistaken for thoracic aneurysm. When an aneurysm compresses a bronchus, bronchiectasis, attended with cough, bronchorrhea, fever, and emaciation, may be the result; but in phthisis the fever and emaciation are more pronounced, tubercle bacilli are present, while the cardiovascular signs of aneurysm are absent.

Prognosis.—The occurrence of perforation and consequent speedy death in unsuspected cases must be recollected. In other instances the end is approached in a very gradual manner, and cases in which rupture does not supervene sometimes pursue the general course of chronic valvular affections of the heart. The condition ends in death as a rule, and the *immediate causes* of the fatal issue are as follows: (1) Rupture of the aneurysm, followed by hemorrhage into any of the adjacent cavities or organs (pericardium, heart, large vessels, mediastinum, trachea, a bronchus, esophagus, lungs, pleura, spinal canal); it may, though rarely, rupture externally, in which case slight hemorrhages occur and life may last for weeks. Lemann's statistics show that in 592 autopsies rupture occurred into the pericardium 148 times, equal to 25 per cent.; externally only 35 times, equal to 5.9 per cent. (2) Gradual asthenia. (3) Direct pressure. (4) Independent diseases, either primary or secondary to, and induced by, the aneurysm. Among these, *pulmonary complications*—fibrinous pneumonia, abscess, gangrene, tuberculosis—are of first importance.

Treatment.—There are two main objects of treatment—first, the promotion of coagulation of the blood, and second, the contraction of the sac. The clotting of the blood within the growth may be greatly favored by retard-

morphin should be given. When there is bulging the pain may be relieved by the ice-bag or by a belladonna plaster.

Dyspnea and great venous congestion are to be met by venesection, and tracheotomy may be required in bilateral paralysis of the abductors. In dyspnea from pressure on the trachea or bronchus, however, tracheotomy would be a valueless expedient. When the aneurysm forms a large external tumor the application of an elastic bandage to the chest may be both agreeable and advantageous, as in a case referred to by Osler.

Among subjects of arteriosclerosis, tortuosity and elongation of the aorta may exist and give rise to some of the signs of aneurysm of the arch. Holzknecht was the first to point out this pseudo-aneurysmal dilatation, but he classified them as dislocations of the aorta. Joseph Sailer and G. E. Pfahler have made fluoroscopic and radiosopic examinations of 18 cases, some of which were autopsied at a later date, and showed that pulsating hemispheric shadows above the heart were not always aneurysms, but often mere tortuosities of the aorta, which cast a shadow from $\frac{1}{2}$ to 2 inches to the left of the fifth and sixth dorsal vertebræ.

The *symptoms* of atheroma with tortuosity are for the most part negative, but certain physical signs which strongly suggest aneurysm are commonly observed. "Probably it would be justifiable to suspect tortuosity in cases in which there is inequality of the radial pulse, slight tracheal tugging, dyspnea, and in which the symptoms are stationary for a considerable period of time and the fluoroscope shows a projection to the left of the descending portion of the arch of the aorta that has no true expansile pulsation" (Sailer and Pfahler).

ANEURYSM OF THE ABDOMINAL AORTA

The vicinity of the celiac axis is the favorite seat of abdominal aneurysm, which is less common than intrathoracic aneurysm, though not rare. It may assume a fusiform or saccular nature.

Symptoms.—The tumor may grow backward; but more frequently it grows forward. Projecting from the *posterior wall*, it usually erodes the vertebræ, and compression of the cord is apt to take place, producing *paraplegia*, preceded by *tingling* and *numbness of the legs*.

Pain is the leading symptom. It may be neuralgic or of a boring or gnawing character, due to destruction of the bone. Rarely, the aneurysm perforates the diaphragm, and finally *ruptures* into the lungs or pleura. Arising from the *anterior wall*, it may early form a well-defined tumor. It may, however, when situated high up or near the diaphragm, conceal itself until it has attained a comparatively large size, as in a case under my care at the Medico-Chirurgical Hospital. *Vomiting* and *gastralgie seizures* may be troublesome, and the fact that *embolism* of the superior mesenteric artery may occur and give rise to severe colicky pains must be recollected. *Jaundice* has been observed.

Physical Signs.—Epigastric pulsation may be *visible*, and occasionally an epigastric swelling. The *palpating* hand detects a heaving, expansile pulsation that may be accompanied by a thrill. When the tumor hugs the diaphragm the pulsation may be double. The femoral pulse is diminished in volume and delayed. An abnormal area of dulness may be present. In most instances a *soft bruit* is audible. The diastolic murmur and shock of *intrathoracic aneurysm* are usually absent.

Diagnosis.—A certain diagnosis demands the presence of a definite growth that is seizable and has a heaving, expansile pulsation. Mere pulsation attended with a thrill and a systolic murmur are insufficient.

Differential Diagnosis.—A *throbbing aorta*, as met with in neurotic females and in anemia (particularly in instances of the traumatic form), is sometimes distinguished from aneurysm of the abdominal aorta with great difficulty. It does not, however, present a pulsating tumor that can be held in the grasp, as in aneurysm.

When *solid growths* lie upon the aorta the latter may manifest pulsation, a thrill, and a systolic murmur, but the very general absence of pulsation (when the patient is placed in the knee-elbow position), owing to the fact that the tumor falls forward, suffices usually to differentiate the condition from genuine aneurysm. Again, expansile pulsation is not evinced by a solid growth.

The **prognosis** is very gloomy. Very rarely, however, nature effects a cure if the conditions be favorable. "Death may result from (a) the complete obliteration of the lumen by clots; (b) compression paraplegia; (c) rupture either into the pleura, retroperitoneal tissues, peritoneum, the intestines, or, very commonly, into the duodenum; (d) embolism of the superior mesenteric artery, producing infarction of the intestines" (Osler).

Treatment.—Apart from the measures indicated for thoracic aneurysm, there is one means of cure that may be tried if the growth be low down—viz., *pressure*. This must be maintained for twenty-four hours at least under an anesthetic. It is best to make steady pressure on the proximal portion of the vessel, and unless practised with great care the sac will be damaged and death ensue.

ANEURYSM OF THE PULMONARY ARTERY

Dilatation of the pulmonary artery is of frequent occurrence in affections that oppose obstruction to the lesser circulation (*e. g.*, mitral disease, emphysema, phthisis). Very rarely extreme dilatation of the vessel is followed by semilunar incompetence, when a diastolic murmur at the pulmonary orifice (second left interspace) becomes audible.

Aneurysms involving the pulmonary artery are quite rare: such as occur are small and of the saccular and fusiform varieties.

The **symptoms** resemble those of *intrathoracic aneurysm*, though they are rarely well marked, owing to the fact that they remain of small size as a rule.

Physical Signs.—Pulsation (and, rarely, a small tumor) is detectable in the second left interspace. *Palpation* may also render appreciable a thrill and diastolic shock. Coextensive with the area of pulsation there may be *dulness* on percussion, and over the second interspace to the left of the sternum a loud *superficial systolic murmur* is heard on auscultation, together with a diastolic shock. Before attaining to a large size, these aneurysms usually *rupture* into the heart itself.

The **prognosis** is altogether unfavorable, the treatment having reference to the principles that are appropriate in thoracic aneurysm.

The **coronary arteries** may be the seat of aneurysm, though exceptionally. The condition arises in consequence of weak points (due to *arteriosclerosis*) in the course of the vessels, and is unrecognizable during life.

ANEURYSM OF THE CELIAC AXIS

This condition is sometimes observed in combination with aneurysm of the upper portion of the abdominal aorta.

ANEURYSM OF THE SPLENIC ARTERY

This branch of the celiac axis is occasionally the seat of aneurysmal dilatation. It may be single or multiple, and while it is small, as a rule, may in rare cases be quite large.

The symptoms are indefinite, but distressing. Deep-seated abdominal pain, which shows a tendency to radiation, forms, with vomiting, and rarely hematemesis, the main features. By percussion a tumor may be mapped out in the left hypochondriac region, the dulness merging with that of the spleen and the left lobe of the liver. Usually, pulsation, and, rarely, a tumor can be felt, and systolic murmur is often heard. The condition may be confounded with gastric ulcer.

ANEURYSM OF THE HEPATIC ARTERY

This is exceedingly rare, the total number of cases on record being about 20. H. B. Schmidt has recently reported a case associated with symptoms of gall-stones, in which, as shown by the autopsy, death was caused by rupture of the sac into the bile-ducts. Schmidt found records of but 5 cases of this mode of termination. Osler and Ross have reported an instance associated with multiple hepatic abscesses.

The symptoms are, in the main, colicky pains, vomiting, hematemesis, and obstructive jaundice. A tumor is rarely discernible, though an abnormal area of pulsation is relatively more frequent. The recognition of the condition during life is entirely conjectural.

Aneurysm of the superior mesenteric artery is of rare occurrence. Pain in the epigastric and lumbar regions, and demonstrable tumor near or directly over the median line of the abdomen, are the symptoms displayed. Detached fragments of the clot may produce embolism of the terminal branches of the mesenteric arteries. The condition terminates usually in rupture into the peritoneal cavity.

Aneurysm of the inferior mesenteric artery runs a course similar to the above. It is quite rare and possesses slight interest.

Aneurysm of the Renal Arteries.—Small multiple dilatations are occasionally seen, but large ones are of great rarity. They are prone to rupture into the retroperitoneal cavity.

ARTERIOVENOUS ANEURYSM

Definition.—An artificial communication between an artery and a vein. A sac may intervene between the two vessels (*varicose aneurysm*) or there may be a direct fistulous communication without an intervening sac (*aneurysmal varix*).

In varicose aneurysm the sac is developed from the structures that mark the boundaries of the communicating duct. The majority of cases are caused by the simultaneous wounding of an artery and a vein. Their most frequent seat is at the bend of the elbow. Pepper and Griffith have analyzed the records of 29 cases in which the ascending portion of the aortic arch had opened into the vena cava.

The symptoms are largely aneurysmal, and, in addition, there appear in rapid sequence great swelling of the veins, cyanosis, and edema of the upper portion of the body. A continuous thrill and buzzing murmur, with systolic intensification, are the chief signs.

In the treatment of thoracic arteriovenous aneurysm the same general plan is to be pursued as advised in the purely arterial variety.

CONGENITAL ANEURYSM

This condition arises because of a defective antenatal development of the elastic coat. It is often multiple, and the tumors are, as a rule, small in size, ranging from that of a pea to a hazelnut. The most common situations for these growths are the coronary and pulmonary arteries. To Eppinger belongs the credit for having pointed out the fact that the aneurysmal walls consist only of the adventitia and intima. *Peri-arteritis nodosa*, a rare condition, which Eppinger holds to be a form of congenital aneurysm, presents the symptoms of general infection rapidly developed. "On examination after death the arteries are found beset with nodules of active inflammatory products, chiefly on the outer coat" (Allbutt). The condition may be met with in children and rarely in adults.

ANEURYSM OF THE BRACHIAL ARTERY

It is of the same size & occasionally the size of an aneurysm, dilated by the force of multiple, and while it is small, as a rule may be cured by rest.

It is usually at its origin, but sometimes deep-seated aneurysms occur, a tendency to traumatic origin with wounds and lacerations of the main trunk. By pressure a tumor may be induced, but spontaneous rupture, the disease merging with that of the spleen, and of the liver. Usually pulsating and soft, a tumor can be distinguished from a solid mass. The condition may be misdiagnosed as cancer.

ANEURYSM OF THE SPHALIC ARTERY

Extremely rare, the total number of cases of record being about 20. The recently reported case associated with symptoms of an aneurysm, as shown by the aneurysm, death was caused by rupture into the pericardium. Schmidt found records of but 5 cases of this condition. Lister and Ross have reported an instance associated with hepatic aneurysms.

It is usually at its origin, but sometimes deep-seated aneurysms occur, a tumor is rarely discovered through an abdominal incision is relatively more frequent. The recognition of the condition is entirely conjectural.

One of the superior mesenteric artery is of rare occurrence. From gastric and duodenal regions, and sometimes tumor near or directly against one of the abdominal, are the symptoms displayed. Laceration of the gut may produce embolism of the terminal branches of the arteries. The condition terminates usually in rupture into the cavity.

One of the inferior mesenteric artery runs a course similar to the superior, but is quite rare and possesses slight interest.

aneurysm of the Renal Arteries.—Small multiple dilatations are common, but large ones are of great rarity. They are prone to rupture into the peritoneal cavity.

ARTERIOVENOUS ANEURYSM

Definition.—An artificial communication between an artery and a vein, with or without an intervening sac (varicose aneurysm) or there is direct fistulous communication without an intervening sac (arteriovenous aneurysm).

Varicose aneurysm the sac is developed from the structures that mark the junction of the communicating duct. The majority of cases are caused by traumatic wounding of an artery and a vein. Their most frequent site is the bend of the elbow. Pepper and Griffith have analyzed the records of 100 cases in which the ascending portion of the aortic arch had opened into the inferior vena cava.

Symptoms are largely aneurysmal, and, in addition, there appear in the lower part of the body great swelling of the veins, cyanosis, and edema of the upper part of the body. A continuous thrill and buzzing murmur, with systolic character, are the chief signs.

Treatment of thoracic arteriovenous aneurysm the same general principles may be pursued as advised in the purely arterial variety.

CONGENITAL ANEURYSM

This condition arises because of a defective antenatal development of the elastic coat. It is often multiple, and the tumors are, as a rule, small in size, ranging from that of a pea to a hazelnut. The most common situations for these growths are the coronary and pulmonary arteries. To Eppinger belongs the credit for having pointed out the fact that the aneurysmal walls consist only of the adventitia and intima. *Peri-arteritis nodosa*, a rare condition, which Eppinger holds to be a form of congenital aneurysm, presents the symptoms of general infection rapidly developed. "On examination after death the arteries are found beset with nodules of active inflammatory products, chiefly on the outer coat" (Allbutt). The condition may be met with in children and rarely in adults.

PART VIII

DISEASES OF THE DIGESTIVE SYSTEM

I. DISEASES OF THE MOUTH

STOMATITIS

CATARRHAL STOMATITIS

(*Stomatitis Erythematosa*)

Definition.—A simple, acute inflammation of the buccal mucous membrane. It is more commonly met with in children than in adults.

Etiology.—As a *primary* affection its causes are mainly mechanical and chemical irritation, such as the presence in the mouth of hard and sharp bodies, dental caries, acids, hot or cold food, condiments, tobacco, certain drugs (as mercury), eruption of teeth, and bad feeding, particularly in ill-nourished children. It is the result often of a neglect of the mouth toilet, leading to the decomposition of accumulated bits of food and mucus, and many cases probably owe their origin to infection. *Secondarily*, catarrhal stomatitis may be associated with certain of the eruptive fevers (scarlet fever, measles, typhoid), also with gastro-enteric derangements, and may follow, by direct inflammatory extension, ulcerative tonsillitis and pharyngitis.

Symptoms.—The *local symptoms* of this affection are those usually seen in an inflammation of a mucous membrane—redness, heat, swelling, and dryness, soon followed by increased secretion and soreness. The lips and gums only, or the membrane of the whole mouth, may be inflamed, and the swollen lips, cheeks, and furred tongue may be indented by teeth-marks. Enlarged and reddened papillæ on the tongue and minute vesicles inside the cheeks and lips from projecting mucous follicles are sometimes seen to terminate in small ulcers. A craving for cold drinks is nearly always noted, and distress, pain on taking food, and a disagreeable taste due to the perverted buccal secretions. **Microscopically**, desquamated epithelium that has undergone partial fatty degeneration, leukocytes, and occasionally red blood-cells are seen. The *Leptothrix buccalis*, micrococci, and bacilli are also present. Aside from restlessness and the symptoms common to slight febrile disturbances, the *constitutional condition* is rarely disturbed, except when the stomatitis is secondary either to inflammations lower down in the digestive tract, or to the specific infectious fevers.

The *course* of the disease is usually acute, and the duration about one week.

The **differential diagnosis** of catarrhal stomatitis is easily made by inspection of the membrane.

The **prognosis**, though favorable, will vary as to time and severity according to the cause.

and ragged ulcers surrounding the necks of the teeth. The latter even become loosened, and in protracted cases the alveolar periosteum may become inflamed and cause necrosis of the bone. Profuse salivation, a foul breath (that once earned for the condition the term of "putrid sore mouth"), occasional slight hemorrhages from the gums, and excessive discomfort, or even pain, on mastication are nearly always present. The tongue is coated, swollen, and tooth-marked; aphthæ are sometimes seen, and the submaxillary glands are generally swollen. The *general symptoms* attending this ailment are those of a lowered state of vitality, produced by an unhygienic environment, or cachexia, or severe illness primary to it, with, usually, moderate fever. Nausea and vomiting or an offensive diarrhea may supervene as the result of swallowing the putrid discharges.

Course and Duration.—Usually acute in its course, the highly debilitating character of the disease may tend to make it chronic, especially when there is alveolar necrosis and a neglect of proper treatment. Ordinarily, with careful management, convalescence may be established in from four days to a week. Goodhart regards the occasional termination of the pyrexia by lysis, with an accompanying improvement of the local symptoms in such cases at least, as suggestive of the specific nature of ulcerative stomatitis.

Neurotic Ulceration.—Under the head of *stomatitis neurotica chronica Jacobi* describes a herpetic (rarely pemphigoid) eruption in neurotic subjects. Sibly has met 3 cases, all of which occurred in women beyond middle age. In all the condition has lasted for a number of years and produced great difficulty in talking and mastication.

Diagnosis.—Upon examining the mouth and noting the characteristic ulceration, the fetid breath and saliva, and the cachetic appearance, the disease is usually recognized, and should not be confounded with the dark, extensive, gangrenous sloughs of noma.

The **prognosis** is favorable in typical cases, though less so in marasmic and neglected cases. When cancrum oris or necrosis of the jaw occur, chronicity, deformity, and even death may take place.

Treatment.—It is well in nearly all ill-nourished, uncleanly kept, and sickly children, as well as in cases in which mercury is to be administered for any length of time, to prescribe mouth-washes of potassium chlorate (gr. xv to ʒj—1.0–30.0), in order to prevent the occurrence of mercurial or ulcerative stomatitis. The *hygienic treatment* of ulcerative stomatitis is important. On account of the contagiousness of the disease cases occurring in a family or in institutions should be isolated, and fresh air, light nourishment, and cleanliness are *sine quâ non* of recovery. The *local treatment* is virtually a specific one in the use of potassium chlorate washes (gr. x—xx to ʒj—0.6–1.3 to 30.0—of rose-water or demulcent), aided by the internal administration of the same salt in small doses. For the disagreeable fetid odor the alternate use of antiseptic washes is indicated. Solutions of carbolic acid or potassium permanganate, in strength equal to or slightly over that indicated in the treatment of aphthæ, or hydrogen peroxid (ʒj—iij to ʒj—4.0–12.0 to 30.0), or alkaline antiseptic solution and water (equal parts), are useful. Penciling the spongy gums with such astringents as tincture of rhatany, silver nitrate (gr. x to ʒj—0.6–30.0), alum, and also with tannic acid solutions, may be necessary. Loosened teeth should not be disturbed, as they may grow firm with convalescence, though surgical interference may be required in cases of necrosis of the alveolar process. Kissel's method in obstinate cases is to curet the ulcers and rub into them powdered iodoform once daily. Careful attention to the teeth is always requisite. During the height of the disease constitutional treatment may have to be directed toward stimulating the languid and lowered vitality. For

the true vocal cords, the stomach, and cecum (Parrot). At first pearly white in color, the curd-like flakes may become yellow and even brown, owing to slight hemorrhages caused by the irritation. Though early adherent, in a few days they become loose, and when brushed off leave a smooth surface; when complicating some serious gastro-intestinal disease or dyscrasia, however, their attachment is deeper, and the deposit may sometimes appear in successive crops. A *microscopic examination* of the thrush patches shows interlacing, irregular, and branched mycelial threads, spores, occasional bacilli, and leptothrix filaments embedded in a mass of granular debris and fetid particles. The buccal fluids are acid in reaction. The *general symptoms* depend upon the associated disease, and are usually those of wasting, artificially nourished children having digestive troubles or a constitutional taint.

Diagnosis.—This may be accurately made upon the discovery of the fungus by microscopic examination. Only very rarely are portions of the thrush organism found in the false membrane of *diphtheritic stomatitis*. *Mild curds* may be readily removed, and are not necessarily associated with the stomatitis accompanying thrush or the grave systemic states. The important point of differential diagnosis arises in the case of *aphthæ*. The following table will express the main points:

PARASITIC STOMATITIS (THRUSH)

Dryness of the mouth.

Whitish, raised spots or patches with no red areola; these are easily removed, leaving no ulcer and causing no bleeding.

Spots are numerous.

Begins in the form of minute spots.

Ulcers not painful. Discomfort depends on the associated stomatitis.

The characteristic thrush-fungus is always detectable with the microscope.

APHTHOUS STOMATITIS

Salivation.

An ulcer with a yellowish-white, depressed base, surrounded by a red areola. The base is removed with difficulty by forceps, and bleeding results.

Usually few in number and discrete.

Not so; ulcers appear, preceded by the formation of herpetic vesicles.

Ulcers exquisitely tender.

No specific micro-organism determined, though probably present.

Prognosis.—This is favorable as regards the thrush alone, but, occurring in marantic children and cachectic adults, its appearance is of grave significance, and may portend a speedy death.

Treatment.—Prophylaxis is of great moment, since it is much easier to keep the mouth clean and the secretions normal, and to attend to proper food, and thus avoid creating a soil for the growth of the vegetable parasite, than it is to prevent absolutely the entrance of thrush spores. Efforts directed toward preventing acidity are especially indicated. This is to be done by the use of mild alkaline mouth-washes, as soda-water and lime-water. The dietary should be carefully looked after, and should exclude sugars and all starchy food; the addition of lime-water to the milk (about 1 part to 4) is a desirable precaution to take, particularly with children. Cleansing the feeding apparatus and the mouth after each feeding is essential both in the prevention of the formation, and in decreasing the further growth, of thrush when present. The local treatment consists in the use of alkaline and antiseptic applications, preferably by means of the spray. Solutions of boric acid or sodium hypsulphite (3j—4.0—of either to 3j—30.0—of water, with the addition of a little glycerin), potassium permanganate, or hydrogen peroxid, are useful. Syrupy excipients are to be excluded. Potassium chlorate may exert a beneficial effect in those cases in which stomatitis is associated, as may also penciling with a solution of silver nitrate. Concetti urges the use of a 3 to 5 per cent. solution of silver nitrate instead of the weaker strength usually employed. The use of the galvanocautery is often serviceable.

Symptoms.—The mucous membrane of one cheek, near the corner of the mouth, is usually first affected, a *dark, ragged, sloughing ulcer* appearing and extending insidiously for two or three days before the substance of the cheek is involved. A *hard and sensitive nodule* may then be felt by grasping the thickness of cheek between the thumb and finger. Brawny induration of the skin over this nodule soon becomes manifest, and then there appear collateral lesions and an unctuous looking, deeply livid, gangrenous spot, soon becoming illous and leaving a black eschar. Perforation of the cheek may occur on the third day, though usually not until a week has passed. There is an *ichorous discharge* of shreds of gangrenous tissue from the unhealthy wound. The odor of the breath is almost intolerable and characteristically gangrenous. The necrosis may extend over one-half the face of the side affected, and may involve the gums and jaws, but seldom does it attack the opposite side of the face. The *general symptoms* of such a grave malady may be slight at a very early period, but with the formation of the eschar they become rapidly severe and typhoid in type. Great prostration, delirium, pyrexia (104° F.— 40° C.), diarrhea, and edema of the feet are common. The course rarely extends beyond two weeks.

Complications.—Septic lobular pneumonia may occur from aspiration of gangrenous particles; colitis and gangrene of the genitalia in females (*noma pudendæ*) are also seen. In those very rare cases that recover, granulations form, the gangrenous edges become clean, and cicatrization follows, often with great disfigurement of the face and even restricted jaw motion.

Diagnosis.—The disease when fully established is easily diagnosed by its characteristic origin, the gangrenous ulcer-nodule, the eschar formation, and perforation, associated with a previous history of measles or other acute infectious fever of childhood. The offensive fetid odor and severe constitutional depression are also of great value.

Differential Diagnosis.—From *anthrax* it differs in that the latter affection is more common in adults, with a history of contagion, and in the fact that malignant pustule starts on the exterior of the cheek, and perhaps in a previous abrasion in the skin. The discovery of the *Bacillus anthracis* in the blood and discharges is conclusive. *Ulcerative stomatitis* of a severe and neglected type may be confounded with cancrum oris, but in the former the destruction of tissue is mainly of the gums and alveoli, the cheeks being simply ulcerated and no extensive sloughing taking place; the breath, though fetid, is not gangrenous, and the oral discharge, though sometimes bloody, is not mixed with shreds of gangrenous tissue (Starr). Finally, the course of ulcerative stomatitis is less severe, a fatal termination being extremely rare.

Prognosis.—Noma is seldom recovered from, the mortality being about 80 to 90 per cent (Bogel). When recovery does take place the development of ectropion, facial deformity, and local disability, with a protracted convalescence, render life burdensome.

Treatment.—Quarantine all cases until they are proved by bacteriologic study to be of a non-diphtheric nature, and the avoidance of mercurialization will also be of undoubted use. The primary indication in the *local treatment* is the arrest of the gangrenous process, thus causing, if possible, a healthy reaction on the part of the surrounding tissues. All sloughs should be cut away, followed by cleanliness of the mouth and wound; and by the application of strong caustics, as fuming nitric acid, and the acid nitrate of mercury, solid zinc chlorid, silver nitrate, carbolic acid, a concentrated solution of perchlorid of iron, Vienna paste, and the actual cautery. For the protection of the healthy parts and for efficiency the Paquelin or the galvanic cautery is probably best. Anesthesia is requisite for such strong measures. Milder applications,

Atropin (gr. $\frac{1}{100}$ —0.0006) and opium have been recommended to decrease the excessive salivary secretion and to allay pain, and hot baths will aid the treatment materially. In severe cases the resulting debility and anemia should be met by the use of highly nourishing liquid foods and by tonics.

Osler points out that the condition of the teeth known as *erosion*, which sometimes follows infantile stomatitis, and especially the mercurial form, is to be discriminated from the deformed teeth of congenital syphilis. In the former the first permanent molars, and then the incisors, are observed to have small pits or discolored and eroded spots, due to a morbid deficiency in enamel formation. The notched and irregular teeth of hereditary syphilis in children (Hutchinson) are sufficiently distinctive.

PYORRHEA ALVEOLARIS

(*Riggs' Disease, Fouchard's Disease, Alveolitis*)

Definition.—A chronic progressive disease, commencing usually as a gingivitis, and advancing along the root of the tooth into the alveolus, with destruction of the tissues of the peridental membrane, and the formation of an abscess cavity as well as an inflammatory absorption, which results in progressive loss of the alveolar bone. The adjacent soft tissues are the seat of cellular infiltration which often tends to clear away after surgical removal or successful treatment of the diseased tooth or teeth.

Historic Note.—In 1865 J. M. Riggs forcibly called the attention of the dental profession to the subject, while William Hunter was the first to insist upon the importance of mouth sepsis, with absorption of pus, as a cause of many septic conditions—*e. g.*, gastritis, enteritis, appendicitis, and pleuritis.

Etiology.—It is probable, as shown by the labors of Rosenow and his associates, that the streptococcus-pneumococcus group of organisms are of special etiologic importance. Recent investigations by Hartzell and Henrici and others ascribe the principal rôle to the *Streptococcus viridans*. The pyogenic staphylococci, fusiform bacilli, and other organisms have been found in the lesions, but some of these at least may be looked upon as secondary invaders.

In 1914 Smith and Barrett insisted upon the etiologic importance of certain parasitic amebas (*Endamæba buccalis*), but their specificity has not as yet been proved.

Symptoms.—The onset is without striking local features. At first the gums become abnormally reddened and slightly swollen and spongy, bleeding when the teeth are brushed. With the progress of the condition these symptoms gradually become more pronounced, with tenderness to pressure and pain, and on inspection a purulent material may be seen exuding either spontaneously or on slight pressure from the orifice at the gingival margin. In well-marked cases the peridental ligament is more or less extensively involved, and retraction of the gum with exposure of the tooth-root is quite common. The tooth teeth affected may loosen.

In all cases that first fall under the care of a physician he should associate with himself a skilled dentist in their diagnosis and study. A roentgen ray examination should not be omitted from consideration. (*Vide Focal Sepsis, 170.*)

Treatment.—This is both local and general, but since the systemic features are due to septic absorption from the oral lesions, the germs causing the latter must be either destroyed *in loco*, or eliminated by the removal, surgically, of the primary pathologic focus, but it is not necessary to sacrifice all of the teeth involved, as the recent results of expert specialists and dental surgeons, confirmed by roentgen ray findings, clearly show.

the compound tincture of benzoin or ammonium chlorid (3j to ʒj—4.0–30.0), favors resolution (Cohen). Abscesses must be incised and washed out with antiseptic solutions. Tracheotomy is rarely called for to relieve the dyspnea. Rectal alimentation with predigested foods may be necessary, and during convalescence ferruginous tonics in glycerin and bland foods should be continued for some time, in order to prevent chronic inflammation and thickening. Any local source of irritation, as from carious or sharp teeth, should be removed.

CHRONIC SUPERFICIAL GLOSSITIS

Definition.—A chronic inflammation of the mucosa of the tongue.

Etiology.—This disease is often preceded by several acute attacks, the habitual use of tobacco, both in smoking and chewing, and of strong spirituous liquors being mainly productive of the original affection. The frequent use of irritating foods is also a factor in some instances.

Symptoms.—The surface of the tongue is continually sensitive and more or less reddened. Often there are seen ovoid patches of various size, smooth and shiny, on account of the loss of papillæ, and separated by furrows that extend to the depth of the mucosa itself. The tongue may also be slightly furrowed in intervening spaces, especially at the base. The general health is somewhat deteriorated.

Diagnosis.—This rests upon the history of the case and upon the results of examination of the organ.

The prognosis is favorable as to alleviation, but guarded as to cure.

Treatment.—The blandest dietary must be insisted on, as well as absolute abstinence from the causal irritants. The local use of demulcents and of mildly alkaline and antiseptic lotions, such as Seiler's tablets in solution, and of solutions of chromic acid or silver nitrate (gr. v-x to ʒj—0.3–0.6 to 30.0) in water or honey, applied once or twice daily by gentle brushing, is to be recommended. General tonics and the avoidance of irritating drinks will be indicated.

GLOSSITIS DESICCANS

A rare disease, chronic in nature and of unknown causation. It is characterized by "the gradual development upon the surface of the tongue of a number of deep fissures and indentations, giving the organ an uneven and ragged look. The pain is due to the frequent presence of excoriations and ulcers in these fissures" (Strümpell). The prognosis of the affection is favorable as regards any danger. The treatment is hygienic, consisting of cleanliness of the mouth and the use of disinfectant mouth-lotions, together with the topical use of alterative or astringent applications, as silver nitrate or chromic acid, to any ulceration.

LINGUAL PSORIASIS (TYLOSIS LINGUÆ)

In this disease there are small regular areas of hyperplasia of the glossal epithelium, eventually causing a map-like appearance of the surface of the tongue—"lingua geographica." The trouble is obscure in its etiology and persists for years. Seldom is there any discomfort associated, although mental anxiety or hypochondriasis may develop.

LEUKOPLAKIA ORIS (BUCCAL PSORIASIS)

In this affection the mucous membrane of the mouth and tongue may be involved. On the lateral borders of the tongue white or bluish-white scar-like spots or patches, often slightly notched, make their appearance. Some of these pass away to be replaced by others, and the affection progresses despite all attempts to cure it. The true cause is unknown, but it has been suggested

enteric, pancreatic, uterine (as gestation), centric (as diseases or tumors of the medulla or of the facial nerve), toxic, systemic (as small-pox, the use of mercury, iodids, pilocarpin, tobacco), and hydrophobic irritation and disease.

Diagnosis.—It should be pointed out that a failure in swallowing the normal quantity of saliva may cause dribbling from the mouth and simulate hypersecretion.

the prognosis is favorable in itself, but dependent on the cause.

treatment.—The causes are to be removed and the general health toned. For stomatitic salivation potassium chlorate is first in rank as an internal local remedy. Iron and arsenic are valuable in neurotic cases, and the acids or hyoscin may be of supplemental use. Atropin (gr. $\frac{1}{100}$ to $\frac{1}{1000}$ —0.0006) and belladonna are almost uniformly successful in idiopathic sialorrhea as in central ptyalism.

XEROSTOMA

(Aptyalism; "Dry Mouth")

Definition.—A morbid arrest of the salivary and buccal secretions:

Etiology.—The disease is probably due to an affection of the nerve supply of all the glands of the mouth (Harris). It may follow sudden mental excitement as a temporary condition. A. J. Hall collected 39 cases, of which 25 occurred in females. In most of the cases the causes were unknown. Not uncommonly xerostoma is an effect of the febrile state, of mouth-breathing (due to nasal obstruction), and of diabetes.

Symptoms.—Apart from the sensation of dryness, mastication, deglutition and articulation are difficult. The *local appearances* show a glazed, red, sometimes cracked condition of the tongue and labial and palatine mucosa. Teeth may become diseased and crumble.

he diagnosis is made on inspection, the **prognosis** depending on the **vability** of the cause, and rightfully being guarded on account of the **ent obstinacy** of the trouble.

Treatment.—Attention to the systemic condition is requisite. Small doses of potassium iodid and pilocarpin (gr. $\frac{1}{40}$ —0.003) in gelatin lamellæ or lozenge form, allowed to dissolve in the mouth with the aid of a sip of water, have been productive of relief. In cases of centric origin the galvanic treatment should be tried.

glassblowers' Mouth.—This condition is found among glassblowers also among musicians. It occurs in about 2.5 per cent. of all glassblowers. Heale, who reports 2 cases, described the condition as a hernial outpocketing of the muscles of the cheeks. The epithelium of the mucous membranes forms the so-called *plaques opalines*. It is often combined with a distention of Steno's duct. In addition to a ballooning out of the buccal mucosa, there may be a disturbance of hearing and cramp-like contraction of the cheek. The parotids may be emphysematous and crepitate on palpation.

SYMPTOMATIC PAROTITIS

(Parotid Bubo)

Definition.—A secondary inflammation of the parotid gland, generally, to septic infection and tending to suppuration.

Etiology.—Not being a primary affection, the causes giving rise to it may be mentioned as follows: (a) Acute infectious fevers, as typhoid, typhus, pneumonia, pyemia, erysipelas; (b) injury or disease of the abdomen or pelvis (Stephen Paget), or of the genito-urinary tract, as mild traumatism or derangement of the testes or ovaries, or even menstruation or pregnancy; gastric ulcer may be accompanied by it; (c) peripheral neuritis with facial paralysis (Gowers).

Most of the cases are septic and indicative of an unfavorable course in the progress of the associated disease. The *symptoms, diagnosis, and treatment* of the parotitis itself fall under the scope of surgery.

Chronic Parotitis.—Mikulicz first described this condition and reported a case in which symmetric enlargement of the lacrimal, and subsequently of the salivary, glands occurred. Kummel and Osler have also recorded cases. It may be caused by lead or mercury and may be secondary to mumps, inflammation of the throat, and chronic Bright's disease. The condition may be painless.

IV. DISEASES OF THE TONSILS

ACUTE TONSILLITIS

Definition.—An acute inflammation of the tonsil or tonsils, affecting either the mucous membrane, the follicles, or the parenchyma, and ending either in resolution, suppuration, or chronic enlargement.

Pathology.—In the *superficial variety* of acute tonsillitis the mucosa is simply red, swollen, and sometimes covered with a thin, soft exudate of mucus. The tonsil itself may also be swollen. In *follicular tonsillitis* the lacunæ become filled with a cheesy exudate which often protrudes from the tonsillar crypts; epithelial and pus-cells, cellular debris, and occasional cholesterol crystals are found in these cheesy masses. In older, darker hued masses an offensive odor is given off, and numerous bacteria are found. In adults, calcareous infiltration of the cheesy little masses may be met with. *Parenchymatous tonsillitis* is shown by a greater enlargement of the tonsil, due to a marked infiltration of all the tissues. Suppuration in the tonsil is frequent, the follicles usually bursting and uniting in abscess formation. Pus may burrow into the cellular tissue surrounding the tonsil, and find its way even down to the clavicle. The *herpetic* or *ulceromembranous* form of tonsillitis, in which an eruption of herpetic vesicles on the tonsils is followed by their rupture and the formation of a lightly adherent membrane, is rare. In *necrotic tonsillitis* (Strümpell) a grayish-white adherent necrotic membrane is observed, that is limited by the inflamed membrane surrounding the mucosa covering the tonsils. The latter are moderately swollen. A dirty ulcer often remains after the slough separates.

Etiology.—*Predisposing causes* are age, sex, temperament, and atmospheric conditions. The disease is most common in youth and in early adult life. Boys and young men appear to be attacked more often than the opposite sex. Tonsillitis is most prevalent during the spring season. The proportion of cases in which tonsillitis precedes rheumatism is probably over 30 per cent. It is certain that one attack of acute tonsillitis predisposes to subsequent ones, particularly when the first attack has left some enlargement of the tonsils. Sudden and extreme climatic changes predispose to the disease.

The *predisposing causes* of acute tonsillitis are most commonly the following: (a) Exposure to cold and dampness, or talking in a cold, moist atmosphere;

(b) exposure and talking in an overheated atmosphere vitiated with smoke or other irritating vapors or gases; (c) specific infectious fevers, as scarlatina, measles, and erysipelas; (d) irritation from hard and sharp foreign bodies or chemical irritants. The exciting cause is the presence of microbes (streptococci, staphylococci, pneumococci). Epidemics of streptococcic infection have been traced to the milk-supply (over 70 per cent. of the cases in Cortland and Homer, N. Y., epidemics occurred among the patrons of a certain dairyman). Capps and Davis¹ suspected that ice cream played an important rôle as a carrier in an epidemic which they reported. They found 11 cows with garget to account for infection of the milk, to some extent at least.

Clinical Symptoms.—Three principal varieties of acute tonsillitis occur clinically, the symptoms of which will be described separately.

(a) **Acute Catarrhal or Superficial Tonsillitis.**—This form is often associated with acute pharyngitis. The earliest *local symptoms* are pain and difficulty in swallowing, the former often becoming quite acute and radiating to the ear and lymphatics at the angle of the jaw, where tenderness on pressure may also be elicited. In speaking a nasal twang is often noticed. During the laborious act of swallowing the sensation of a lump in the throat, especially when the mouth is dry, is commonly complained of. Simple stomatitis may be associated, and rarely there is a slight cough with the painful expectoration of a sticky mucus which accumulates in the throat (Browne). There may be salivation, with fetor of the breath. *Inspection* shows the tonsil to be red and swollen. Though dry and glazed at first, the surfaces soon become covered with a thin exudate of mucopus, which is easily detached by brushing, gargling, or “hawking” the throat. There is usually some accompanying redness, and also a *tumefaction* of the uvula and faucial pillars. The *constitutional symptoms* at the outset are mildly febrile. The attacks usually come on rapidly, and last but a few days. The pneumococcus variety, however, runs a longer and more rebellious course. *Otitis media* may follow the extension of the tonsillar inflammation.

(b) **Acute Lacunar or Follicular Tonsillitis.**—In this form, which is quite common in children, not only the mucous membrane lining the crypts is inflamed, but that covering the surface of the tonsils also, giving rise to more or less associated *catarrhal tonsillitis*. The *local subjective symptoms* are, as in the preceding variety, pain, tenderness, and difficult deglutition. The tonsils are seen to be covered with small, slightly prominent, whitish-yellow spots or patches of a characteristic creamy exudate corresponding to the position of the crypts and numbering from two to eight or ten or more. These little masses or plugs may be pressed out of the follicles with a spatula. A predominance of pus cocci and cells may rarely forerun the further formation of little follicular abscesses, and even of slight erosions and ulceration of the mouths of the lacunæ. Unlike simple catarrhal tonsillitis—at least in so far as simultaneous involvement is concerned (Cohen)—both tonsils are usually affected in this trouble, though one to a greater degree than the other. The whole tonsil is considerably swollen, and in severe cases the cervical lymph-glands also. The *constitutional symptoms* of follicular tonsillitis may be quite severe. The disease may be ushered in with a pronounced chill, headache, aching of the back and limbs, marked anorexia, and insomnia, along with a rapid rise in the temperature to 103° or 104° F. (39.4–40° C.)—in children as high as 105° F. (40.5° C.). Slight albuminuria is an exceptional finding, but acetonuria is more common (25.6 per cent.—Reiche). The general depression may be so great as to simulate adynamia. Though sudden in its onset and rapid and often intensely acute in its progress, the disease seldom lasts more than five or eight

¹ *Arch. Inter. Med.*, 1914, xiv, 650.

these have been referred to under the heading of Morbid Anatomy. The *constitutional disturbances* are severe, especially in children, though they seldom last longer than a week, and are followed by a rapid convalescence. The cervical glands are not swollen to the same extent as in diphtheria. The occurrence later of palatal and pharyngeal *paralysis* in a supposed case of necrotic tonsillitis would point to its true diphtheritic origin.

(e) **Streptococcus Tonsillitis** (*Septic Sore Throat*).—An epidemic form, which was first observed in Christiana in 1908 and later in England, has more recently been described by certain American authors, *e. g.*, J. A. Capps, D. J. Davis and E. C. Rosenow, and C. E. A. Winslow. The onset is sudden, with or without a chill. The throat presents a diffuse redness with much mucoid secretion. The crypts of the tonsils are always filled with an exudate, and a grayish membrane resembling diphtheria may spread over a large part of the tonsil. "The fever, the muscular pains, the prostration, and the constitutional symptoms were out of all proportion to what one would expect from the amount of local involvement."¹ The pulse is relatively slow and the leukocytes are only moderately increased. The acute symptoms may subside in a few days, but at the end of a week or ten days the patient suddenly manifests great enlargement of the cervical glands without suppuration, as a rule. Visceral complications occur most often in the group of cases having little or no glandular involvement but marked constitutional disturbances. Otitis media is frequent and bacteriologic examination shows an encapsulated hemolytic streptococcus of high virulence. This organism of the lacticus type has been found in milk—23 out of 92 samples (D. J. Davis²).

Diagnosis.—The appearance of the several forms of acute tonsillitis, associated with the clinical history of each case, should enable a ready diagnosis to be made in the majority of cases. A difficulty may, however, arise in discriminating follicular tonsillitis from diphtheria, and apparently transitional forms are not uncommon. The appended table gives the important points of differentiation between these diseases:

FOLLICULAR TONSILLITIS

A soft, pultaceous, yellowish-white deposit occurs in spots or patches situated over the mouth of the follicles, with areas of redness intervening.
The exudate is easily removed, leaving a smooth surface.
The deposit is always limited to the tonsils (important).
If the creamy deposits unite to form a continuous layer, removal is either not followed by re-formation, or very late.
May have high temperature, lasting only a day or two, and falls after administration of sodium salicylate. Albuminuria extremely rare, if present at all.
Cervical lymphatic glands seldom or slightly swollen.
Complications rare and mild.
Bacteriologic test shows no special organism; often, however, streptococci and staphylococci.

DIPHTHERIA

A tough, ashy-gray, continuous, and uniform pseudomembranous deposit covers the tonsils, pharynx, or soft palate.
Very adherent, and can be torn off in strips only, leaving a bleeding surface.
The pillars of the fauces and uvula are involved as well.
Removal of the membrane is followed by re-formation within twelve to twenty-four hours.
Persistent elevation of the temperature, which is not materially influenced by salicylates; more or less albuminuria is common.
Usually markedly swollen glands.
Complications frequent and grave (cardiac failure and paralyses).
Bacteriologic examination shows presence of Klebs-Löffler bacillus.

Cases seen early, with severe constitutional symptoms and red and swollen tonsils having no deposit, may give rise to the question whether *simple angina*

¹ *Pract. Med. Series*, 1912, vi, 110.

² *Jour. Infect. Dis.*, December, 1918, p. 559.

acid, or potassium permanganate in weak solution, may be serviceable. Mild counterirritation at the angle of the jaw by means of iodine or slightly irritating embrocations is helpful.

Early scarification of the tonsils as a depletory measure and painting with cocaine (10 per cent.) I have found useful to bring about resolution.

Astringent sprays containing alum or silver nitrate are often efficacious after a day or two. When the case is fully developed, the atomization of a warm solution of cocaine (4 to 8 per cent.) or lime-water is useful. The external application of the ice-collar is indicated. Should gargling be possible, nothing is better than hot water or milk. If, in parenchymatous tonsillitis, fluctuation be detected or suppuration be even suspected of commencing, the prompt use of the bistoury (the blade being guarded by wrapping with cotton or adhesive plaster), with the production of free bleeding or the discharge of pus, will give great relief. The patient's head, especially if it be a child, should be tilted forward during the operation, so as to allow most of the blood and pus to pass into the mouth. When incision of the tonsil fails to bring pus, it has been advised to puncture through the anterior pillar, where pus may be formed in the cellular tissue in front of or behind the tonsil. When the tonsillar enlargement threatens life through suffocation, excision of the tonsils, laryngotomy, or tracheotomy may have to be performed.

VINCENT'S ANGINA

(*Ulceromembranous Tonsillitis; Trench Mouth*)

Definition.—An acute inflammation of the tonsil and, in severe cases, peritonsillar tissues, characterized by a pseudomembranous exudate and, later, ulceration.

Etiology.—The condition is much more frequent than was generally supposed before the introduction of laboratory methods of diagnosis. The disorder more frequently attacks children than adults, probably because hypertrophied tonsils seem to predispose to the infection. Campbell and Dyas¹ state that syphilitics are predisposed to this infection; also that a Klebs-Löffler bacillus carrier readily becomes infected. The specific organisms responsible for the condition are the elongated fusiform bacillus and the *Spirochæta anginae vincenti*.

Symptoms.—The most characteristic symptom is the severe pain in the throat. The breath is offensive and there may be considerable salivation. Systemic symptoms are usually lacking, but fever and tachycardia may be present in a mild degree. Prostration is sometimes out of proportion to the apparent severity of the other systemic manifestations of the toxemia. Upon examination there will be found upon the tonsil an ulcer about the size of a ten-cent piece covered with a dirty grayish-yellow membrane. Attempts to pull off the membrane will usually cause bleeding of the tissue to which the membrane is attached. The regional lymph-glands are enlarged and the muscles of the neck stiff and tender. Courcoux and Debré² describe recurring Vincents' angina, having encountered a number of cases after varying intervals of time. Various skin eruptions, lymphangitis, bronchitis, and other septicemic complications may be encountered.

The **diagnosis** is of importance because of the necessity of differentiating the condition from diphtheria, particularly from the early stages of this latter disease, and from syphilis. This may be done most readily by staining and examining under the microscope a smear from the lesion. Probably many cases are unrecognized, failing smear examinations when diphtheria is unsuspected, and are diagnosed acute tonsillitis.

¹ *Jour. Amer. Med. Assoc.*, June 2, 1917, p. 1596.

² *Ibid.*, 1918, lxxi, 73.

The **treatment** consists in the local application of 1 per cent. of silver nitrate solution or methylene-blue. A good dentist should be consulted. Prompt cures have followed the local use of arsphenamine two or three times a day. General management includes the use of individual personal eating drinking, and bathing utensils, a semisolid diet, sodium cacodylate intramuscularly daily, and the control of such symptoms as may arise.

CHRONIC TONSILLITIS

(*Hypertrophied Tonsils; Adenoid Vegetations*)

Definition.—Enlargement of the tonsils (faucial and pharyngeal), due to chronic inflammation or hypertrophy, and usually associated with or causing a perverted local and systemic condition.

Pathology.—The faucial tonsils show a true chronic hypertrophy of the lymphoid and fibrous elements. If the latter predominate the organs will be smaller and more indurated. They may be rough on the surface from “distended lacunæ or ruptured follicles” (Berkley Robinson), the latter being in a state of chronic inflammatory thickening, and showing caseous degeneration of their contents. The growths in the vault of the pharynx are adenomatous papillomata; they are either sessile or pedunculated, and are fleshy in appearance and consistence and very vascular. They range in size from a grain of wheat to an almond kernel (Allen), and project from the pharyngeal vault, lying in the depression posterior to and on a line with the fossa of the eustachian tube (Rosenmüller’s fossa). “Hypertrophy of the pharyngeal adenoid tissue may also be present without great enlargement of the tonsils proper” (Osler). A congestive type of nasal catarrh in adults often accompanies, or is the result of, neglected adenoid growths and hypertrophied tonsils. Chronic pharyngitis may be associated.

Etiology.—The *predisposing causes* of chronic hypertrophy of the tonsils are: (a) heredity; (b) age, most frequently between five and fifteen years; (c) sex, boys appear to be affected more frequently; (d) hygienic surroundings.

The *exciting causes* are usually previous attacks of acute tonsillitis, either simple or that which is symptomatic of diphtheria or scarlatina. According to Harrison Allen, adenoid growths from the normal lymphoid tissue of the vault of the pharynx (pharyngeal tonsils) may be congenital, and are “in some way associated with the canal which is found in early fetal life penetrating the brain-case and uniting the anterior part of the pituitary body to the lining membrane of the pharynx.”

Symptoms.—*Local.*—With slight or moderate enlargement there may be few or no symptoms. There may be simply an increased secretion of mucus, and a susceptibility to fresh anginal attacks or to severe tonsillar manifestations in diphtheritic or scarlatinal attacks.

The first symptom to attract the attention is the direct effect of nasopharyngeal obstruction—*i. e.*, *oral respiration*. This mouth-breathing is visibly labored and abnormally audible, and is especially marked at night, the child’s respiration being noisy, snorting, and irregular. Sleep is disturbed by paroxysms of dyspnea, sometimes due perhaps to reflex spasm of the glottis. Nightmare follows as a result of imperfect aëration of the blood supplying the brain on account of the obstruction to perfect respiration. The act of swallowing is rendered difficult by the faucial obstruction, and is often painful, owing to the superadded acute tonsillar trouble that is so liable to occur in the hypertrophied glands. Indirect results of chronic tonsillar enlargement are a *laryngeal stridor* and a *croupy cough*. Sometimes *asthmatic attacks* coexist, and seem also to be due to the hypertrophy. An excessive secretion of mucus in the pharynx is a common symptom, and causes hawking in subject—

past young childhood. The *hearing* is often impaired, and tinnitus aurium is complained of, being the result of pressure of the growths against the orifice of the eustachian tube or of extension of inflammation from the nasopharynx. Absolute deafness may result, and the senses of taste and smell are likewise diminished or perverted. *Inspection* of the fauces will show the tonsils bulging as two lumps covered with thick mucus, or the latter may ooze around the uvula from the pharynx. In mouth-breathers of long standing the superior dental arch is narrowed and the hard palate is highly arched. The breath is fetid, owing to the cheesy, inspissated exudate in the tonsillar crypts. In very old cases a tonsillar *calculus* may be felt, and is the result of calcification of the secretion.

The *facial expression* is characteristically stupid and apathetic; the disposition is dull, irritable, and stubborn; the lips are thick, and a vacant stare is in the eyes. *Speech* is slow, phonation nasal in quality and articulation of the nasal consonants *n* and *m*, *l* and *o* is changed or muffled. *Stammering* may be associated. The anterior nares may be dilated and present a pinched appearance above their openings.

The prolonged interference with respiration gives rise to a peculiar chest conformation simulating that of rickets (*chicken-breast*). The ribs are prominent anteriorly, and there is a marked forward angle at the manubriogladiolar junction, as well as a grooved depression at the ensiform cartilage. Depressions between the widely separated ribs exist anteriorly also. Posteriorly, and at the base of the chest in particular, the intercostal spaces are practically absent on account of the closeness of the ribs. The upper part of the chest is very narrow and the shoulder bones quite prominent. On percussion the hepatic area of dulness is diminished on the chest wall, but increased downward and to the left. The first cardiac sound is weak. On inspiration there is a retraction of the intercostal spaces in the lower and lateral thoracic regions.

The resulting thoracic deformity may express itself principally as an excavation of the lower sternal area (*trichter brust*). When chronic tonsillar enlargement leads to oft-recurring asthmatic attacks, the chest may become *barrel shaped*, as in emphysema, at an early period of life.

The *general symptoms* of tonsillar hypertrophy are more marked when the growths exist in the pharyngeal vault alone. Developmental processes in children, such as dentition, and at puberty, particularly when the voice changes are looked for, are often retarded or perverted. Anemia, probably resulting from the action of hemolytic streptococci which Davis¹ found in 97 per cent. of crypt cultures, headache, especially during study, cardiac palpitation, enuresis, and habit chorea of the facial muscles may be associated with general capriciousness, mental dulness, indisposition to intellectual exertion, drowsiness, and sullen irritability. The term *aprosexia* has been given to the loss of power to concentrate the mind for any length of time that is so characteristic of these cases.

Diagnosis.—Inspection of the fauces will reveal enlarged tonsils. The act of gagging, however, often causes the tonsils to rotate forward and inward, making them appear larger really than is the case. Tonsils which have been the seat of recurrent inflammations are frequently contracted and held down by scar tissue. Such tonsils may be seen with difficulty and may be considered normal on account of their small size. Only by a careful examination by a skilled specialist in a certain number of cases is one able to discover a chronically diseased tonsil which may be causing some systemic condition. Adenoid growths of the pharyngeal vault may exist without tonsillar enlargement, and can be detected by posterior rhinoscopy or by the insertion of the finger into the nasopharynx.

¹ *Jour. Amer. Med. Assoc.*, 1920, lxxiv, 318.

V. DISEASES OF THE PHARYNX

PHARYNGITIS

ACUTE PHARYNGITIS

(*Pharyngitis Acuta Simplex*)

Definition.—An acute catarrhal inflammation of the mucous membrane of the pharynx.

Pathology.—The mucous membrane is congested diffusely or in patches, and there may be an inflammatory exudate in, and a consequent swelling of, the submucosa and the contained glandular structures. The surface of the membrane is more or less coated with a viscid mucus.

Etiology.—*Predisposing causes* are: age, it being more frequent in adolescence and young adult life; a depraved constitution; digestive disorders, and a rheumatic, gouty, or scrofulous diathesis. The usual exciting cause is exposure, particularly of certain portions of the body, as the neck and chest, to cold or to sudden changes of temperature and to irritating vapors. An acute nasopharyngeal catarrh, by bathing the pharyngeal mucosa with its irritating secretions, may set up the trouble. *Epidemic pharyngitis* is probably a manifestation of influenza. Acute simple pharyngitis may be a complication of scarlatina, measles, and small-pox (*exanthematous pharyngitis*). Micro-organisms are present, the streptococci often predominating.

Symptoms.—*Locally*, the affection is ushered in with a feeling of dryness and soreness, especially on swallowing. With the production of the mucous secretion a tickling sensation provokes *hawking* or a slight *throat cough* and efforts at expulsion. The catarrhal process may extend to the larynx and cause some hoarseness, or to the eustachian tube, causing dulness of hearing. Movements of the neck are *painful* and *stiff*, particularly if there is, as is often the case, slight involvement of the lymph-glands. *Inspection* of the throat shows the pharynx, often the posterior pillars of the fauces and the soft palate, and even the anterior pillars and tonsillar surfaces, to be deeply reddened and tumefied; the coursing veins are enlarged, and particles of a bluish-white secretion appear here and there. Sometimes the pharyngeal follicles become subject to acute inflammation, and appear as elevated, discrete, red spots (*herpetic pharyngitis*—Mackenzie).

At the *onset* of this affection there may be chilliness, followed by slight fever, headache, an accelerated pulse, a dry skin, and anorexia. The *pharyngeal symptoms* seldom last more than from three to five days, when resolution takes place, some tenderness of the pharynx, however, remaining for a time.

Diagnosis.—On examination of the throat there should neither be any difficulty in diagnosing the affection nor any likelihood of confounding the condition with simple tonsillitis.

The **prognosis** is always favorable. In weakly patients, however, there is a liability to subsequent attacks.

Treatment.—In the early stages sucking of small pieces of ice does much to allay the congestion and irritability. A spray of cocain or menthol in alcohol (2 per cent.) may also be used, followed by a 4 per cent. solution of eucalyptin. Eucain may be substituted for cocain (2 per cent. solution), and recommended by Gibbs and others. Dobell's solution is always to be recommended for its alkaline, sedative, and antiseptic action. Swabbing the pharynx with a silver nitrate solution (gr. xl to the ounce—2.6–30.0) is, according to Mackenzie, of great benefit.

In well-established cases relief is often obtainable by medicated steam inhalation, as with the compound tincture of benzoin. In rheumatic cases inhalations of guaiac (gr. iij—0.19) are useful. The sipping of hot milk in which sodium bicarbonate has been dissolved is grateful.

The *general treatment* embraces measures directed at the fever and the diathetic condition. A hot foot-bath and a calomel purge, with belladonna, acetanilid, or aconite for the fever and pain, and sodium salicylate (gr. lx to lxxx—4.0–5.5—in the twenty-four hours) may be required. The diet, of course, should either be liquid or semisolid.

Persons susceptible to repeated attacks must exercise caution in regard to exposure to severe cold and weather changes, irritating vapors, and the like. Daily cold sponge-baths may be used to harden the skin. Tonic, nutrient treatment is also frequently called for.

MEMBRANOUS PHARYNGITIS

(*Pharyngitis Crouposa*)

Definition.—An acute superficial inflammation of the pharyngeal mucosa, characterized by the formation of a whitish false membrane, due usually to the streptococcus.

Etiology.—The principal causes of this form of pharyngitis are exposure of persons in debilitated health to cold or an impure or a septic atmosphere, particularly during epidemics of such diseases as scarlatina.

Symptoms.—The local and general symptoms are those of ordinary sore throat, though of a more severe type.

Diagnosis.—The pseudomembrane is thin, of a yellowish-white color, and appears in small patches over the pharynx. It is easily detached, and this feature, together with the presence of small vesicles or ulcers and the absence of grave constitutional disturbances, serve to differentiate this affection from diphtheritic pharyngitis.

The **prognosis** is favorable.

Treatment.—Local applications of solutions of hydrogen peroxid or potassium permanganate (gr. x to the ounce—0.6–30.0) are very satisfactory. For the painful dysphagia the sedative and soothing remedies suggested for simple acute pharyngitis may be used. Internally, sodium benzoate (gr. v to xv—0.3–1.0) in glycerin, elixir of calisaya, and phenyl salicylate have each been recommended. Tonic treatment is nearly always needed.

CHRONIC PHARYNGITIS

Definition.—A chronic inflammation of the mucous membrane of the pharynx. It may consist of either a hypertrophic or an atrophic involvement of the follicles, or both processes may coexist.

Varieties.—(a) Chronic nasopharyngeal catarrh; (b) chronic hypertrophic pharyngitis or nasopharyngitis (*pharyngitis sicca*); (c) follicular or granular pharyngitis. The last named is probably the result of, and nearly always is associated with, chronic simple (or hypertrophic) pharyngeal (or nasopharyngeal) catarrh.

Pathology.—The mucous membrane in simple chronic pharyngitis is either reddened, thickened, and viscid (hypertrophic form), or pale, thin, and dry (atrophic form); in both instances dilated and tortuous veins are prominently shown. In the follicular variety the pharyngeal mucous glands are swollen into little red, glistening nodules studding the congested membrane. The enlarged follicles are due to a hyperplasia of lymphoid cells and an accumulation of retained dried-up secretions.

Etiology.—A protracted impairment of the general health, especially in those who overexert mentally and are of sedentary habits, is a common *pre-disposing cause* of chronic pharyngitis. Repeated acute attacks may precede the affection. It is most common in adolescent and middle life.

The *exciting causes* are frequent and prolonged overuse and strain of the

voice in clergymen, singers, teachers, army officers, and street venders; irritation from tobacco smoke, chemical vapors, and continued exposure to cold air. Among prevailing causes may be mentioned postnasal adenoids, deviations of the septum, and neoplasms. It may arise from gastric disorders.

Symptoms.—In all varieties of chronic pharyngitis the *local discomfort* is often very slight, and more annoying than painful, except when an exacerbation takes place. There is a sensation of *dryness* and *tickling* or *burning* in the throat and the desire to clear the throat of sticky mucus by *hawking* or a *short cough*. These symptoms are usually worse on rising in the morning, especially if some unfavorable influence has been exerted during the night previous, the throat being dry and a viscid secretion having collected. Swallowing is seldom interfered with.

If the larynx is somewhat affected by extension of the pharyngeal inflammation, *hoarseness* and a *dry, hacking cough* are produced. After using the voice there is a sense of fatigue, with huskiness and irritability.

The *local appearances* of chronic pharyngitis vary according to the form of the affection present in the case. In chronic catarrh of the pharynx a considerable collection of mucus is seen adhering to the mucosa and extending downward from the posterior nares. The senses of hearing and taste may be impaired. The uvula is frequently elongated, and its tip may rest on the base of the tongue. A nasal intonation of the voice is sometimes provoked. The posterior nares as seen by the rhinal mirror are often stopped up by foul secretions or by hypertrophy of the nasal mucous membrane. Headache and attacks of vertigo may occur.

Chronic hypertrophic pharyngitis and follicular pharyngitis (*clergyman's sore throat*) are commonly associated. The thickened, reddened, pimply, vein-coursed appearance of the mucosa is characteristic. The follicles may be seen sometimes as polypoid elevations, and the pharyngeal tonsil may be found by the finger to be enlarged (Köl liker).

In the dry, *atrophic pharyngitis* that occurs more often in later life, and as a sequel of the simple chronic or follicular variety, a pale, smooth, relaxed, lustrous, and often quite painful membrane is observed.

The *general symptoms* are usually those of a weak, debilitated, nervous constitution, though in mild cases the general health may be unimpaired. In atrophic pharyngitis considerable cachexia may be present.

Diagnosis.—Care should be exercised in discriminating the variety of chronic pharyngitis present in any given case, so that the treatment may be planned accordingly. Careful and repeated inspection of the throat renders the diagnosis easy unless ulceration has taken place: in such cases a *tuberculous* or *sypilitic* sore throat must be eliminated by the superficial character of the ulcers, by their ready response to proper treatment, by the history of the case as to specificity, and by the absence of marked pain or symptoms pointing to tuberculosis. When due to gastric disturbance the lower throat will be deeply congested and the tongue will be irritable, with red papillæ standing over its base (Price-Brown).

Prognosis.—This should be guarded as to cure on account of the stubborn resistance to treatment and the difficulty in removing unfavorable influences. Acute exacerbations are liable to recur unless rigid caution is practised at all times in avoiding the cause of the trouble.

Treatment.—The local use of astringent and alkaline antiseptic sprays or the nasal douche is usually recommended, but has only a palliative effect. Silver nitrate cauterization may be tried. The only effectual means, however, of curing the follicular or hypertrophic variety is that used by most throat specialists, namely, the wire galvano- or actual cautery. Applications of silver nitrate (gr. x to the ounce—0.6–30.0) and the internal use of the oleoresin

VI. DISEASES OF THE ESOPHAGUS

ESOPHAGITIS

ACUTE ESOPHAGITIS

Definition.—An acute inflammation affecting either the mucous membrane or submucous tissues of the esophagus, or both.

Pathology.—The ordinary morbid changes of an acute esophagitis are those of a simple catarrhal inflammation of the mucosa. It is rather characteristic of the condition that there is no increased secretion, a sponginess and rapid desquamation of the epithelium taking place instead, and causing a granular appearance of the membrane. Occasionally the mucous glands are swollen, and may break down, with the formation of small follicular ulcers. Catarrhal erosions may also be seen here and there. A croupous or diphtheritic exudate is seldom found in the lower portion of the esophagus, and small-pox pustules are rarely, if ever, seen. A diffuse or circumscribed purulent inflammation of the submucosa may dissect up the mucous membrane so as to considerably diminish the esophageal caliber; pus is usually discharged into the tube. In severe cases of poisoning (*corrosive esophagitis*) sloughing may extend into the muscular layer, and may produce a foul, dark, hemorrhagic mass. A fibrinous cast of the gullet has been vomited up by a hysteric woman (Birch-Hirschfeld).

Etiology.—The causes of acute esophagitis, other than traumatic, are rare. Under the later are included the *mechanical*, *thermal*, and *chemical* irritants, such as the presence of foreign bodies and the swallowing of hot liquids, corrosive poisons, "concentrated lye," mineral acids, and arsenic. The condition may also be the result of the following: (a) an extension of catarrhal inflammation of the pharynx; (b) specific infectious fevers, as typhoid, typhus, and pneumonitis; (c) diphtheria (*pseudomembranous esophagitis*) by the extension of pharyngeal diphtheria; (d) small-pox, giving rise to a pustular inflammation of the gullet; (e) local disease, as carcinoma of the esophagus, glandular or vertebral abscess, or laryngeal perichondritis (Strümpell).

Symptoms.—Pain during deglutition may be referred to the region of the esophagus, and a steady, dull pain may exist beneath the sternum. *Dysphagia* and *regurgitation of food* may be caused by spasm in severe cases. Mucus, blood, and pus may be discharged later. The absence or mildness of pain is not a true indication of the gravity and extent of esophageal inflammation.

Sequelæ.—Simple catarrhal or follicular ulcers may appear, and the necrotic form of the disease may be followed by suppurating ulcers, which, if healing takes place, may cause cicatricial stenosis.

Diagnosis.—This may be based upon the localization of pain, especially during deglutition; upon the pain occasioned by the passage of the esophageal sound; and upon the mucus, blood, or pus adherent to its bulb on withdrawal, provided carcinoma at the cardiac orifice of the stomach can be excluded. The expulsion of a pseudomembrane (diphtheritic) from the gullet should be differentiated from esophagomycosis (thrush), especially in children. The diagnosis of the particular form of esophagitis will depend upon the facts elicited relating to the etiology.

The **prognosis** is good in mild cases, and should be guarded in those associated with grave disease. Death may occur in either the purulent or necrotic form.

Treatment.—This is entirely symptomatic, and in severe cases is of little value. A soft, bland diet, preferably of milk, may be borne in ordinary in-

Lerche emphasizes "hot fluids" as an important predisposing cause. The *exciting causes* are of uncertain origin. It has been alleged that various forms of protracted irritation of the mucous membrane may cause the development of carcinoma; and especially has this point been maintained in connection with the frequent occurrence of carcinoma of the gullet in toppers. Yamagiwa found a history of consumption of alcohol in 83.9 per cent. of 311 cases. It is also believed by some that as gastric carcinoma may develop from the scars of old ulcers, a like condition in the esophagus may act as a nucleus for a carcinomatous growth.

Symptoms.—*Dysphagia* is the earliest symptom of esophageal carcinoma with beginning stenosis of the tube. This gradually and steadily increases, so that liquids alone can be swallowed, and later regurgitation even of small amounts (not above 3 ounces) of liquid foods takes place. Occasionally, at the start, dysphagia amounts to a brief choking sensation only. There may be considerable *pain*. I saw an instance with the late Dr. W. Frank Haehnlen, in which mucus was almost constantly regurgitated, and bronchiectasis developed near the close.

The *ejecta* may contain cancerous fragments, blood, and mucus. The dysphagic symptoms may subside spontaneously, owing to the disintegration and ulceration of the growth, or the dysphagia may be so slight as to be masked by the prominent symptoms of hepatic or pulmonary carcinoma and gangrene secondary to a very flat esophageal carcinoma. Or, without secondary manifestations of such a growth, the esophageal symptoms may rarely be latent. The cervical glands may be enlarged.

The most important *general symptom* of esophageal carcinoma, as of this malignant growth elsewhere, is the progressive emaciation, which increases with the stenosis and obstruction to the entrance of nourishment into the stomach. Though seemingly anemic, the patient's blood may contain an excessive number of corpuscles in a given bulk. This is due to inspissation from failure to absorb water and food into the body.

Course, Duration, and Termination.—The disease is chronic, becoming progressively worse, and is often beset with grave complications (*vide infra*). It seldom lasts longer than one and a half years, and the duration of medullary carcinoma of the gullet is usually shorter. A fatal ending is inevitable by inanition and exhaustion, or as the result of metastasis and secondary complications.

Complications.—These follow extension of the cancerous growth to neighboring parts. Thus, involvement of the larynx, trachea, and bronchi has been noted. The cancerous ulcer may also perforate the pleura, the pericardium, or the aorta or its branches, and cause fatal hemorrhage. The vertebrae have been eroded, and compression of the cord, with resulting paraplegia, may take place.

Paralysis of the vocal cords may be the effect of pressure by the growth upon the recurrent laryngeal nerve; most frequently pulmonary gangrene is due to perforation of the lung or to the inspiration of cancerous and decomposing particles that have been regurgitated.

Diagnosis.—All other causes of dysphagia must be excluded. *Enlarged tonsils, pharyngeal tumors*, pressure from without by cervical intrathoracic tumors, as *aneurysm*, or by displacement of the sternal end of the clavicle, and the presence of *foreign bodies* or *cicatricial strictures* of the gullet—all figure in the production of difficult deglutition. The history of the case, the age of the patient, the progressive emaciation (cancerous cachexia), and the obstinately increasing dysphagia will enable us to exclude the other affections named. In using the esophageal bougie for diagnostic purposes great care

NEUROSES OF THE ESOPHAGUS

MUSCULAR SPASM

(Esophagismus)

Definition.—A spasmodic contraction of the muscular layer of the upper and lower portions of the esophagus.

Etiology.—It is almost always a secondary affection, met with not infrequently in hysteria, hydrophobia, and rarely in chorea and epilepsy. In some cases the esophageal bougie could be passed only with a great deal of difficulty during the spasm. It may be observed in aged males, and especially those suffering from hypochondriasis, though in many no evidence of a morbid temperament can be elicited. It may be due to reflex causes, originating, for example, in the uterus; thus, in some cases, it occurs only during the menstrual state. Spasm may complicate all of the lesions of the esophagus, and an organic stricture.

Symptoms.—The chief subjective characteristic is *dysphagia*. Although liquids can be swallowed, solids, as a rule, cannot. Poststernal pain is sometimes noticed, and choking signs are quite common. In the hysterical variety emotional disturbances are found among the prodromata. The general nutrition remains good.

Diagnosis.—The etiological factors must be carefully weighed in connection with the symptoms and the valuable testimony gained by the use of the sound. The bougie on reaching the constriction is rather tightly gripped, and although gentle pressure soon causes it to relax. After the subjective symptoms are over the sound passes without the slightest difficulty. The regurgitated and vomited masses contain neither blood nor pus. An examination with the esophagoscope allows the diagnosis to be easily made. In some cases the dysphagia may be due to pharyngeal paresis. The *elderly hypochondriac*, as before stated, liable to develop a similar condition, which must not be confounded with true cancerous stricture. The prognosis is good. Guisez speaks of severe spasms with lethal tendency.

The treatment is directed to the disease on which the condition is found to depend, and this must receive careful attention. The sound should be used as previously indicated under the discussion of Esophageal Stricture. Its use has often been followed by speedy and permanent cures. A special electrode with which to apply electricity to overcome the spasm of the cardia has been employed.

PARALYSIS OF THE ESOPHAGUS¹

In extensive bulbar paralysis, when adjacent parts are involved, we may suspect the existence of esophageal implication, though there be no objective evidence to adduce in confirmation. Doubtless the esophagus rarely shares postdiphtheritic paralysis also. Dysphagia is the leading symptom. An unusual peculiarity belonging to diphtheritic paralysis is the fact that solids are more readily swallowed than liquids.

DILATATION OF THE ESOPHAGUS

Pathology and Etiology.—Diffuse dilatation of the esophagus is usually secondary to organic stricture at or near the cardiac orifice. In accordance with the common law of compensation, the first effect of the stenosis is to en-

For remarks on the treatment of this complaint the reader is referred to the section on Nervous Diseases.

are *congenital* in origin. When *acquired* they are the result of a localized lesion in the muscular coat, through which the mucous membrane bulges like a hernia. This is owing to repeated slight pressure occasioned by the passage of food. When once such a process is started, various factors tend to continually enlarge the pouch. Chief among these are the morsels of food that find lodgment and naturally tend to augment the size of the diverticulum by dragging it downward. The sac may finally attain a diameter of not less than 4 inches (10 cm.). Its situation is nearly always on the posterior wall at the laryngo-esophageal junction, and its form is usually saccular or pear shaped. In most instances have been met with in males after middle life. The cause of the weakened area at which the diverticulum occurs is to be found sometimes in injury, but more frequently in an antecedent inflammation. Histologic changes are observed only in the mucous and submucous layers, these anatomic elements together forming the pouch.

Traction diverticula are produced by the fringe of tissues that often becomes adherent to the upper aspect of the esophagus, and from their mode of occurrence they will obviously be more or less funnel shaped. Their dimensions are small. They are more common in children than in adults, for the reason that in the former, more frequently than in the latter, do the bronchial glands suppurate, with subsequent cicatrization. This circumstance affords an explanation of the fact that traction diverticula are usually seated on the anterior wall of the esophagus near the bifurcation of the trachea.

Clinical History.—*Traction* diverticula do not, as a rule, give rise to clinical symptoms. Exceptionally, however, as the result of the mechanical irritation caused by bits of food that are retained in these funnels, ulceration may occur and be followed by perforation of their apices. In this manner the bronchi are perforated (causing pneumonia and pulmonary gangrene), the pleura (causing empyema), and, more rarely, the pericardium (causing purulent pericarditis).

Pressure diverticula when small cannot be recognized owing to the absence of signs and symptoms. When they attain considerable size, however, they are often attended with severe symptoms. The earliest clinical manifestation is difficulty in swallowing; some of the food enters the sac, and, if allowed to remain, undergoes putrefactive decomposition, causing *fetor of the breath*. From time to time, and especially on attempting to swallow, the partly or wholly filled condition of the pouch excites *nausea* and *vomiting*, associated with prolonged *strangling*; this results in the ejection of a portion of the accumulated contents. These contain no hydrochloric acid. After such an attack the patient is unable, temporarily, to swallow food, and in consequence the limited amount of food taken signs of inanition soon appear; this may finally become extreme, and is sometimes the immediate cause of death. The appearance of a *pear-shaped swelling* in the side of the neck has been observed. As the tumor enlarges it displaces the larynx and presses upon the enlarged vessels—more rarely upon the superior laryngeal nerve—giving rise to dyspnea and distressing fits of coughing.

Diagnosis.—A point in the differentiation of this affection is the enlargement of the sac after meals (not all the food passing into the stomach), and its disappearance after being emptied. Another discriminating sign is the effect of compression by the hand in causing the contents (“air and sodden food”) to flow back into the mouth. In those instances in which the tumor is absent we may demonstrate its existence by the use of the esophageal sound. If the sound passes into the sac, the descent will soon be arrested. If, however, the instrument fails to enter the mouth of the pouch, it readily glides into the stomach. An elbowed sound, bent at an obtuse angle near the tip, is useful

the pain constant, and is it local or diffused? Does it radiate to the back or epigastric regions?

Appetite.—The loss of appetite (anorexia), or a desire for unusual foods (bulimia), are frequently noted. When the appetite is increased, or the patient becomes hungry a short time after a meal, it is referred to as "bulimia."

One should determine further whether the appetite comes on when the patient begins to eat, or disappears at the sight of food, or after a few mouthfuls of food are taken. The taking of abnormally large amounts of food at certain times only is termed "polyphagia." Where the appetite is not satiated, even after a full meal, we refer to such condition as "acoria."

Thirst.—In certain maladies the thirst is increased, while in a second class of conditions there is little or no desire for water or other liquids. Inquire whether thirst is allayed by taking water.

Taste.—Many gastro-intestinal conditions are accompanied with an unpleasant, sour, bitter, or sticky taste which may be experienced only on waking, but it may be more or less persistent.

Deglutition.—Does the patient swallow both solids and liquids naturally; is he liable to cough while eating, and does such effort cause discomfort or pain?

Pyrosis.—This is a burning sensation in the epigastrium and sternal region. Note at what time, before or after food, it is experienced, its duration, and how it is influenced by various foods.

Regurgitation.—Note how long after taking food this annoying symptom is observed, and also whether the food tastes sour. Where the contents of the stomach are expectorated, it is referred to as regurgitation, but should it be only partly chewed and swallowed, it is termed "rumination."

Hiccup.—The time at which hiccup occurs, and whether or not it is accompanied with a burning sensation in the throat or by an unpleasant odor, are points of clinical value. Prolonged hiccup is of grave significance.

Nausea.—Is it occasional or frequent, and how influenced by food and by exertion?

Vomit.—Inquire carefully as to the frequency of the vomiting; how influenced by pain; when the stomach is empty, after soft food, solid food, or is it excited by certain odors? The quantity and consistency of the vomit, as well as whether it ever contains fresh blood (red), or blood that has lingered in the stomach for a time (coffee brown vomit)?

Such special symptoms as constipation, mental dulness, sleepy and giddy sensations, and a blurring of objects are not infrequently observed in gastric disorders.

EXAMINATION OF THE GASTRIC FUNCTIONS

Secretory Function.—While gastric secretion normally is continuous during the later stages of gastric digestion, the activity of the secretory function of the stomach diminishes, and to obtain accurate knowledge of any pathologic condition of the organ, examinations of the gastric contents must be made under conditions as nearly like the physiologic as possible. Reliable results cannot, therefore, be obtained from an examination of ordinary vomita, but the contents of the stomach must be procured at a definite period after a so-called test-meal (*vide infra*).

Numerous test-meals have been offered to the profession, but those that have been found most satisfactory are "the test-breakfast of Ewald and Boas"

"the test-dinner of Leube-Riegel." The former being simpler and easier of preparation than the latter, it is the oftenest used.

The *Ewald-Boas test-breakfast* consists of one or two rolls (50–70 gm.) and one cup of tea or water (300–400 c.c.). I constantly advise the use of a roll and a glass of water. About an hour after this meal has been taken

0.5 per cent. alcoholic solution) are added; in the presence of free HCl a rose- or cherry-red color is produced. Combined HCl gives a negative result. The presence of acid salts, peptones, mucin, and starch (in the usual percentage) do not interfere with this reaction.

Lactic Acid.—Uffelmann's Test.—The reagent should always be freshly made, as follows: To 10 to 15 c.c. of a 2 per cent. aqueous solution of carbolic acid add 1 or 2 drops of neutral ferric chlorid, when an amethyst-blue color will appear. To 1 or 2 c.c. of the mixture add a few drops of the filtrate, and if lactic acid is present a canary-yellow color appears. Sources of error may be overcome by shaking 5 to 10 c.c. of the filtrate with double the quantity of ether, and, after allowing the ether to separate and pouring it off, adding more ether to the filtrate, again shaking, and repeating the washing. The ether is then evaporated almost to dryness in a water-bath. To the residue about 1 c.c. of water is added, and to this an equal quantity of the Uffelmann reagent from a pipet; and if a canary yellow now appears, positive proof of the presence of lactic acid is afforded. Bread contains lactic acid, and hence it is better to employ a thin gruel made by adding to a quart of water flavored with salt $\frac{1}{2}$ ounce of oatmeal-flour. Boas states that no lactic acid is present in the filtrate several hours after this test-meal, except in cases of carcinoma of the stomach. Lactic acid in the stomach contents also occurs with fermentation-stagnation from either obstruction or deficient motility.

A more reliable test for lactic acid than the foregoing is that of Boas, as follows: Digest the filtrate several times with ether to remove the fatty acids; add a few drops of phosphoric acid and boil. Transfer the mixture to a distillate flask; add H_2SO_4 and MgO_2 ; heat, and lactic acid will pass over. This can be conducted into a strongly alkaline solution of iodine and potassium iodid. The presence of lactic acid is then shown by the production of iodoform, which can be recognized by its odor and by the precipitate formed.

Fatty or Volatile Acids.—Heat to boiling a few cubic centimeters of the filtrate in a test-tube, over the mouth of which place a strip of moistened blue litmus paper; the presence of fatty acids will change the paper to red.

Acetic Acid.—In large quantities this acid is detected by its odor, and in smaller quantities its presence is determined by neutralizing with sodium carbonate the watery residue of the ethereal extract, and adding neutral ferric chlorid, when a blood-red color develops. Quantitative estimation of certain constituents is desirable.

Total Acidity.—To 10 c.c. of the filtrate add 1 or 2 drops of a 1 per cent. alcoholic solution of phenolphthalein, and decinormal solution of sodium hydrate is added slowly from a buret until the reddish color that appears fails to disappear on shaking. The number of cubic centimeters of the decinormal solution normally required ranges from 4 to 6; hence, if these be multiplied by 10, we have 40 to 60 as the percentage of acidity. Under pathologic conditions these numbers may be either higher or lower. This total represents both free and combined acids. If no organic acids be present, the above figures will represent the percentage of HCl. The latter is also reckoned thus: If it required 5 c.c. of the decinormal solution of sodium hydrate to be added to 10 c.c. of the filtrate to get the red color (alkalinity) with the phenolphthalein, we say the acidity is 50, and multiplied by $0.003,646 = 0.1823$ per cent. of hydrochloric acid. The normal range of percentage is from 0.1 to 0.22.

Estimation of Free HCl.—Mintz's method.—To 10 c.c. of the filtrate add a decinormal solution of sodium hydrate from a buret until no reaction is given with Günzburg's reagent. The number of cubic centimeters of the decinormal solution used, multiplied by 10 and then by 0.003,646, gives the percentage of free hydrochloric acid.

due to a defective ptyalin supply.¹ For methods of detecting *occult blood*, p. 799.

The Tests for the Motor Function.—More important than the secretory is the motor function of the stomach. There are several tests.

The oldest method is that of *Leube*. It consists in washing out the stomach six to seven hours after a large meal, preferably consisting of beef soup (6 oz.), beefsteak (6½ oz.), bread (1½ oz.), and water (6½ oz.), or from two to three and a half hours after Ewald's test-breakfast. Normally, the stomach should be empty within these periods of time, so that if a residue remains denotes a lack in the motor force. Boas recommends the giving of 400 c.c. of water to which 20 drops of chlorophyll (concentrated aqueous solution) have been added. Thirty minutes after the patient has drunk this the stomach-tube is passed. With normal motility about 50 to 60 c.c. are recovered. A simple test is to have the patient eat a few prunes with the meal taken the evening before the test-breakfast. Their recovery the next morning is indicative of hypomotility.

PHYSICAL OR EXTERNAL EXAMINATION

This implies the well-known physical signs—inspection, palpation, percussion, and auscultation, including succussion or splashing.

Inspection.—(a) *General*.—This may give an idea of the nature of the illness as well as its severity by noting whether the patient appears to belong to the neurotic group, the general health often being good, or whether the patient is emaciated, or has with the latter the cachexia of a malignant growth. In cases of the stomach attention should be directed to the mouth, and especially to the teeth; these may be of causal importance in gastric ailments, and frequently prevent their cure.

(b) *Local Inspection*.—In patients with thin and relaxed abdominal walls the contour of the stomach can be plainly noted; especially is this the case in the case of large, dilated stomachs or in those that have been displaced. The examiner is greatly aided by inflating the stomach with air or gas. The former is to be preferred for the reason that the supply is easily regulated; he is enabled to watch the different steps of the distention, and after the examination is completed the air is allowed to escape through the tube. For this purpose an ordinary stomach-tube is most convenient, and its passage is to be effected in the same way as in removing the gastric contents. A double bulb-attachment is connected with the external end of the tube, by means of which air is forcibly forced into the stomach (*Runeberg's method*).

Frerichs' method is sometimes used. It consists in administering 3j (4.0) tartaric acid, dissolved in half a glassful of water, and immediately afterward 3j (4.0) of sodium bicarbonate, dissolved in the same amount of water. Effervescence now occurs, with a progressive visible distention of the organ. There are many objections to this method.

The inflated stomach presents a circumscribed protuberance, usually in the epigastric and also in the umbilical region if the organ is dislocated or displaced. The air may find its way into the intestine, producing a visible change in the contour of the abdomen. Tumors and other abdominal enlargements may also be recognized, and an idea obtained as to which organ is involved, after making due allowances for displacement, as in gastroptosis and gastric carcinoma. Exaggerated peristaltic waves may also be noticeable in the upper portion of the abdomen, usually when associated with the stomach.

The tests for the estimation of the combined acids, of some of the fatty acids, and any of the products of proteolysis are complicated and unnecessary in an ordinary physical examination.

and in the lower portion if it is in the small intestine. Peristalsis is increased from various causes—inflation of the stomach, external tapping, neuroses, pyloric obstruction, and the like.

The value of the gastroscope in inspecting the interior of the stomach is, I think, questionable. Gastrodiaphany (illumination of the stomach) is sometimes useful in showing the fundus extending to a lower level (at the navel) than is indicated by percussion, and in indicating the presence of tumors in the anterior wall of this organ.

Palpation.—This elicits at times more trustworthy information than inspection. The patient should be in the recumbent position, the lower limbs partially flexed on the abdomen, and the head low. The examiner should stand at the right side of the patient and use the right hand, which should be warm. With the palmar surface down gentle pressure should be made with the fingers and the ulnar side of the hand. If the abdominal wall is tense, it is best to distract the attention of the patient from the examination by talking to him. In this manner we can corroborate inspection as to the size, shape, and position of the stomach, and can detect morbid growths as well as determine their consistency and movability.

Deep palpation, by increasing pressure with a slightly rotary movement, elicits the degree of sensitiveness, tenderness, or pain, whether circumscribed as in ulcer or diffuse as in generalized inflammatory states (enterocolitis, peritonitis). In deep-seated tumors palpation should also be made in the knee-elbow position, and if movable they may drop to the abdominal wall. Gurgling and succussion sounds of some diagnostic value may be elicited. In some instances relief from pain may be noted on pressure with the broad hand in neuroses. Variations in the degree of tension and of resistance are found and prove helpful.

Percussion.—The patient is placed in the recumbent position; the examiner uses his fingers and endeavors to discriminate the slightest differences in the note, and percusses lightly. If the stomach is empty or partially filled with gas, it gives a lower tympanitic sound than the colon. To ascertain the size and position of the stomach by percussion the process should begin at the symphysis pubis and follow the median line upward. The upper border of the stomach is at the ensiform cartilage, the lower about two fingerbreadths (3 cm.) above the umbilicus. If the upper margin is some distance below the ensiform, displacement of the organ is indicated; this depression may be occasioned by various diseases of the thorax. The stomach may be elevated by great distention of the gut or peritoneal sac.

It is well to trace the limits of resonance of the stomach and of any areas of dulness met with, so that their size and position may be graphically represented. The differences in the percussion-note over the stomach and colon may be greatly exaggerated by inflating the former. Runeberg's method is to be preferred. By employing light percussion the limits of the stomach can now be easily and accurately defined, unless the transverse colon be at the same time greatly distended with gas. In such instances Dehio's modification of Piorry's method is to be resorted to. It consists in giving about 1 liter (1 quart) of water in fractional doses while the patient is standing; one-quarter of the liter is swallowed and percussion practised, when a dull note will be obtained over the most dependent portion of the stomach. A second quantity of equal amount is given and a re-examination made, and so on, the object being to ascertain to what point the lower border sinks on the addition of more fluid. Boas holds that this method tests effectively the tone of the stomach, and that a *marked* descent of the lower border after each addition of water is indubitable evidence that there exists weakness or atony of its walls. If a

oplasm originates posterior to the stomach or colon, inflation of the latter may cause the previous circumscribed dulness to disappear.

By striking the abdomen in the epigastric region splashing-sounds may be reduced. This sign is of diagnostic value in dilatation of the stomach, though its absence does not contradict the presence of the dilatation. Again, the splashing-sound is obtained in a fasting stomach, it may give a clue to some abnormal condition. The stomach may contain large quantities of fluid and no splashing-sound be obtained. Caution should be exercised lest the splashing-sound sometimes produced in the transverse colon be mistaken for that originating in the stomach; in the former the sound is usually associated with diarrhea, while in the latter constipation usually obtains. The outlines of the stomach can be most satisfactorily determined by auscultatory percussion.

Auscultation.—Various sounds are heard, none of which are pathognomonic of any diseased condition.

Succussion-sounds are produced by shaking the patient, and, if the stomach is dilated and contains fluid, a splashing sound may be audible some distance from the patient, and when heard after digestion has been completed they indicate some abnormal condition. Heard below the umbilical line, they usually indicate dilatation. In motor insufficiency (atony) of the stomach, all splashing-sounds are audible after swallowing a few ounces of water. Partial obstruction of the cardiac orifice causes a delay of the “deglutition murmur” (a hissing sound followed in six or seven seconds by either gurgling, tinkling, or splashing), as heard over the esophagus with the stethoscope while the patient is swallowing a liquid, “while in complete or almost complete closure of the cardia, this murmur is absent” (Ewald). The stomach may be roughly outlined by noting the change in sound that occurs when the stethoscope is placed over the stomach, as air is pumped in through the stomach-tube by a small bulb. The stethoscope is placed below the presumable lower border of the organ and is then moved about one inch toward the stomach after each squeeze of the bulb. As soon as the stomach is reached the sound of the air entering the viscus becomes clear and almost metallic as contrasted with the former less distinct dull tone heard over the abdomen elsewhere. By moving the stethoscope radially towards the stomach from all directions the various borders can be outlined with a fair degree of precision.

Roentgen-ray Examination.—By means of plates or the fluoroscope, much diagnostic information may be gained. It is to this method of examination that so much has been added to our knowledge of the physiology of the stomach and with a clear conception of the physiology has come greater ability to appreciate functional and organic changes. The roentgen ray is able to show the movements, size, shape, and position of the stomach. Variation in these factors may be caused by pathologic changes in the stomach, so that the diagnosis of ptosis, of atony, of ulcer, of cancer, or stenosis, may be made by this method, when the older methods fail. Functional disturbances may also be recognized by the study of the passage of the bismuth meal through the stomach. The motor functioning power is readily learned; from this certain secretory disturbances may be inferred.

MALPOSITION OF THE STOMACH

The stomach may occupy a truly vertical position in consequence of the persistence of the normal infantile condition or of improper clothing—*e. g.*, long-continued pressure from corsets. Unless an angular condition of the

advanced as a cause for the condition: (1) that it is due to an acute hypersecretion of gastric juice; (2) that it is the result of acute loss of tone in the gastric musculature; (3) that it develops as a result of obstruction of the duodenum by the mesentery of the small intestine where the duodenum passes under it.

Clinical History.—Since the diseases causing dilatation are numerous and diverse, the clinical history presents great variations. The symptoms of atony are sometimes overshadowed by those of the causal affections. The early stages when there is simply a certain degree of atony without much dilatation, are usually associated with varying indefinite gastric complaints. As the atony of the muscle wall progresses, dilatation occurs and with it a train of marked symptoms. Among these symptoms, *increased hunger and thirst* are frequently observed, partly due, most probably, to inanition. The thirst is also due, according to von Weinig, to the fact that the stomach does not readily absorb water, and the pyloric obstruction prevents the passage of water into the intestines. *Vomiting* occurs at intervals of several days, the matter ejected amounting to from 1 to 3 gallons (4–12 liters). Occasionally the vomiting occurs more or less regularly some hours after feeding. The clinical characters of the *vomit* are strikingly peculiar. The ejecta often contain remnants of previous meals, are, as a rule, excessively acid, emitting a sour odor, and on microscopic examination they show bacteria, sarcinæ, and torulæ in great numbers. The vomitus undergoes fermentative changes very rapidly, is ill-smelling, the odors being mainly due to sulphuretted and phosphuretted hydrogen. It consists of acetic, butyric, and lactic acids and partially decomposed food (HCl being usually absent), and on standing separates into three layers—an upper layer of brownish froth, a middle one of grayish-brown fluid, and a lower one composed of remnants of food. The acid contents of the stomach are not infrequently regurgitated, causing *pyrosis*. Eructations of foul gases are also common. A dragging pain is often present in the upper abdomen, most intense after eating.

Certain *general symptoms* almost invariably ensue. Progressive emaciation naturally follows, sometimes becoming extreme. A characteristic symptom is *muscular cramp* affecting the calves of the legs and sometimes spreading to the flexors of the arms and the abdominal muscles. Owing to the fact that but a small amount of liquid reaches the intestines, and also to the impaired absorption of the stomach, there are *constipation* and *scanty* urine, usually alkaline in reaction. The nervous phenomena of gastritis are in evidence and insomnia is often pronounced. *Loss of consciousness* has been met with. *Tetany* has also been observed. A striking instance is reported by J. T. Whitcomb, in which nearly all the muscles of the body appeared to be in a tetanic condition. Cardiac palpitation and arrhythmia are often present and are induced principally by the effects of the dilatation. Nocturnal dyspnea (asthma?) may develop.

Physical Signs.—*Inspection* may reveal a rounded prominence just above the umbilicus, patient in the supine posture, and just below the umbilicus when standing. In the epigastric region there is sometimes a noticeable depression. The outline of the stomach may be made distinct by the patient drinking an effervescing draft, and may sometimes be readily seen. The outline of the greater curvature is at times visible, “passing obliquely from the 10th of the tenth rib on the left side toward the pubes, and then curving upward to the right costal margin.” Sometimes peristalsis is visible through the abdominal walls, and rarely the peristaltic waves are seen passing from right to left. These movements may be excited mechanically by various manipulations. *Palpation.*—The increased resistance of the walls of the stomach and their peculiar elasticity aid us in mapping out the contour of the stomach with more precision by palpation than by inspection alone. The move-

tines as quickly as in health. *Gastroptosis* may be distinguished by absence of decided motor insufficiency and by finding, on inflation, the lesser curvature lowered.

Acute Gastric Dilatation.—Acute dilatation of the stomach has a sudden onset. The *pulse* is small and rapid, but the temperature is subnormal. "The absence of a rise of temperature allows peritonitis to be excluded" (Neck). Cyanosis is a common symptom, and pain often a prominent one. The signs of shock are often the only symptoms present. Vomiting of large quantities of a clear watery fluid may occur, usually with relief of the symptoms. Examination will usually show marked tympanitic distention of the whole upper abdomen. If the stomach-tube is inserted large quantities of a watery, low acid (absent free acid) fluid may be expressed. The patient frequently passes into a condition of collapse that may prove speedily fatal. Acute dilatation may arise in the course of chronic gastrectasis. Some cases represent a mere episode in the course of the chronic disease (Veeder, Todd).

The **prognosis** in the *acute form* is uncertain, though the majority of cases recover; the condition may possibly merge into the chronic form.

Chronic dilatation offers a bad prognosis, most instances being utterly incurable. Obviously, it depends greatly upon the causal conditions. A resort to surgical interference sometimes gives promise of a more favorable subsequent course in cases of cicatricial stenosis. Cases of dilatation that are not secondary to pyloric obstruction, however, give a more favorable prognosis on the whole.

Treatment.—One of the chief aims of the physician should be to lessen the labor of the muscular coat and to prevent the continual necessity of passing the usual contents of the stomach into the intestines. This is to be accomplished by careful attention to the character and amount of food taken and by frequent cleansing of the stomach. It is necessary to thoroughly empty the organ by lavage, repeated daily. Perhaps the best way in which to thoroughly empty the stomach is by the use of the stomach-tube, as will be detailed under Chronic Gastritis. Recently this has been replaced by the siphon apparatus as a simpler and more convenient mechanism than the former, and one not so likely to be attended with harmful effects, though perhaps less efficacious. The long course of these conditions renders it desirable that the patient should, whenever possible, be taught to wash out his own stomach. On account of the fermentative and putrefactive changes going on in the ingesta it is necessary to use weak antiseptic solutions for this purpose, suitable ones being a 3 per cent. solution of boracic acid or a 1 per cent. solution of salicylic acid. Subsequently warm water alone may be employed. Lying on the right side for an hour after meals, so that the opening in the pylorus is on a lower level with the rest of the stomach, is worthy of trial. The *diet* should be composed chiefly of fluids, given in small quantities and at stated intervals. If the pyloric obstruction be not too far advanced, tender meats, eggs, and other easily digested albuminous articles of food may be allowed in moderate quantities. Since gastric digestion and absorption are very often markedly impaired, it is well to include those substances that are digested and assimilated after leaving the stomach, though they must be given in a fluid state. In no other manner can we bring such marked relief from gastric symptoms as by a suitable dietary, and in no other manner can the nutrition of the patient be so markedly improved. The weakened condition of the muscle walls is due to overstrain and to degenerative processes; hence after having minimized the labor thrown upon it, we should attempt to overcome its parietic state by the employment of such agents as strychnin and electricity. Stockton, Reed, and others have obtained good results from direct electrization of the stomach by the use of special electrodes; it improves motility and

lessens the size of the organ. Exercises to develop the muscles, abdominal massage, and suitable bandages are also useful. For the associated catarrhal state the remedies recommended under Chronic Gastric Catarrh may be employed.

The deficiency of intestinal fluid is to be met by rectal injections of a weak solution (gr. v to ʒj—0.3–30.0) of sodium chlorid, not less than one pint of this solution being injected twice daily. In addition, nutrient enemata should be employed when, despite proper regulation of the dietary, loss of flesh and strength continue. For the anemia and debility tonics are indicated, particularly iron. Finally, surgical intervention often becomes necessary, and should not be too long delayed.

For *acute dilatation*, lavage of the stomach every hour or two if necessary, followed by complete rest and stimulation, with strychnin, pituitary preparations, eserine salicylate (dose, gr. $\frac{1}{8}$), and especially saline infusion, are the chief items of treatment. Place the patient upon the stomach with slight inclination to the right side so as to mechanically compress the dilated stomach and possibly unkink the duodenum (Morris).

INFLAMMATORY DISEASES OF THE STOMACH

ACUTE CATARRHAL GASTRITIS

(*Acute Gastric Catarrh*)

Definition.—An acute catarrhal inflammation of the mucous membrane of the stomach, attended with more or less severe local and constitutional symptoms.

Pathology.—The postmortem evidences of an acute inflammation of the gastric mucosa are distinctive only of the graver, fatal forms. Observations upon cases of gastric fistula, however, have shown that in milder grades the morbid appearances are similar to those characteristics of acute catarrhal inflammations of the mucous membranes normally exposed to view. Thus, at first there are small irregular patches of redness, dryness, and ecchymosis. Later, serum effused from the congested vessels, and mixed with an increased quantity of mucus, escaped leukocytes, and desquamated epithelium, is present. Hemorrhagic erosions may be seen; the mucous membrane is now thickly swollen, softened, and covered with a tenacious mucopus. Infiltration and swelling of the solitary lymph-follicles are frequent; these sometimes form minute abscesses that rupture and result in follicular ulcers. The gastric tubules may be filled with a granular debris of epithelial cells. The above-described changes are more pronounced near the pylorus.

Etiology.—The *predisposing causes* of acute gastric catarrh embrace those various impairments of the system in which the normal functional activity of the stomach is altered or diminished. These are seen as the result of (a) improper hygienic surroundings; (b) malnutrition; (c) the various anemias; (d) in gouty and rheumatic subjects; (e) in the tuberculous, cancerous, and malarial dyscrasias; (f) associated with chronic passive hyperemia of the stomach due to emphysema of the lungs, cirrhosis of the liver, and renal and cardiac diseases; (g) in sickly and delicate children, in convalescents from acute diseases; and in enervated chronic invalids. (h) Persons having chronic gastric catarrh are predisposed to superadded attacks of the acute disorder.

The *excitants* are mainly (1) dietetic. These include the ingestion of much indigestible food; food or drink that is too hot or too cold (*thermal*); sour and highly seasoned articles; the too free use of condiments; and especially the eating of decomposed canned goods and tainted meats. In cases due to the latter the fermentative and putrefactive agents (acetic, lactic, and butyric

and the ptomaines) are the immediate causes of the catarrhal inflammation and tend to produce the constitutional disturbances, sometimes typhoid in nature, that give rise to the so-called "gastric fever." The term *toxic gastritis* has been applied to those cases due to gluttonous meals. Excessive indulgence in spirituous liquors is a common cause. Certain drugs, as the salicylates, iodids, bromids, arsenic, and mercury, produce the intense form of toxic gastritis, *vide* p. 762.) (3) Acute infectious fevers, such as typhus fever, and scarlatina, provoke the disorder (*infectious gastritis*), as do also malarial fevers, especially when of the pernicious variety. The influence of cold as an excitant of this disease has very probably been overestimated. (5) The *mycotic* origin of the condition cannot any longer be denied. Among the micro-organisms incriminated are the anthrax bacillus, the *Candida* fungus, the *Oidium albicans*, and the yeast fungus. (6) Animal parasites (*e. g.*, ascarides, tænia, oxyurides, etc.) may cause gastritis. (7) Gastritis followed "gassing" in the recent war.

Clinical History.—The symptoms of the ordinary or milder variety of gastric catarrh are embraced in the description of the "subacute gastritis" or "acute dyspepsia" of some writers. Soon after eating there are uneasiness, fullness, pressure, distress, and, perhaps, a dull pain referred to the epigastrium. It is common, also nausea, eructations of gas or liquid, and, less often, vomiting. The vomitus consists of undigested food, considerable mucus, and fluid constituents that are sometimes bile-stained. The percentage of acid in the stomach-contents is variable, although either absent or greatly diminished as a rule. The tongue is coated. The general condition of the patient is usually unimpaired, and the average duration is less than twenty-four hours. In severer cases the symptoms before stated are intensified, and particularly nausea and vomiting. Physical exploration discloses slight prominence of the epigastric area, with more or less tenderness on palpation. The tongue is red and heavily coated, the breath unpleasant as a rule, the patient complains of a flat or bitter taste in the mouth. Constitutional symptoms appear, and the onset is often marked by rigor and a febrile reaction, the temperature rising to 102° or even 103° F. (38.8°–39.4° C.). Herpes may appear on the face and skin—a fact that points to the infectious nature of this complaint. The pulse is usually accelerated, and there are indisposition to exertion, headache, dulness, and other nervous symptoms. An erythematous cutaneous eruption is often present, particularly in febrile cases in children. The marked constitutional disturbance is due to the toxic effects of the products of fermentation and decomposition.

In the gassed soldier there follows, after a period of persistent nausea with vomiting lasting a few hours or days, pains in the stomach and esophagus, burning, and pyrosis after eating. There may be an acute febrile gastro-enteritis lasting for about two weeks. Hyperemia of the mucosa of the alimentary canal with hemorrhagic suffusions are noted at necropsy.

Complications.—Constipation is a comparatively frequent complication, and diarrhea a comparatively infrequent one. Either coincidently or by direct extension the duodenum is similarly affected, and in some instances colic becomes an accompanying feature. The duration of this variety of disease rarely exceeds four or five days.

The diagnosis of the lighter, afebrile forms of the disorder is not attended by the slightest difficulty. A logical diagnosis in cases in which well-marked constitutional and general symptoms appear is not easy. The definite etiology, the burning (affording temporary relief), the pain or tenderness, the sudden rise in temperature, and the equally sudden fall at the end of a few days, however, are most unequivocal.

Differential Diagnosis.—The absence of prodromata, of rose spots, of the

peculiar temperature-range, and of enlargement of the spleen serve to distinguish this complaint from *typhoid fever*. The instances of indeterminate etiology may present a clinical picture not to be differentiated from certain infectious diseases. Here a careful analysis of the local symptoms and signs will usually lead to a correct conclusion, despite the apparently complete identity of the general disturbances. Close observation of the behavior of any obscure case for two or three days will usually enable the physician to arrive at a correct diagnosis. In children headache and vomiting are symptoms often so well marked as to create a striking resemblance to *tuberculous meningitis* but the latter can be discriminated by the history and longer duration. In children acute gastritis with an erythematous rash is often mistaken for *scarlet fever*. The final elimination of the latter disease is usually easy, however, in consequence of the absence of angina, of the typical tongue, the hard and very rapid pulse, and the peculiar desquamation affecting the hair and the nails.

Prognosis.—Quite generally the prognosis is good. When, as sometimes happens, however, the disease is purely secondary, the prognosis must depend largely upon the primary affection. Many persons suffer from repeated attacks of gastric catarrh, each increasing the liability to subsequent attacks.

Treatment.—Our chief aim should be to remove the cause and then to give the stomach complete rest. Hence, whenever the disease is distinctly traceable to errors of diet, emetics of the blandest sort should be employed; large drafts of warm water usually suffice, but lavage is to be preferred in some cases. This should be followed by a purge made up as follows:

R.	Hydrarg. chlor. mitis,	gr. j (0.065);
	Sodii bicarbonatis,	gr. xx (1.300);
	Sacchari lactis,	gr. xv (1.000).
	M. et ft. cht. No. vj.	
	Sig. One every hour as directed.	

The stomach must now have absolute rest for about twenty-four hours, when pancreatized milk or milk boiled with lime-water may be given at stated intervals. If nausea and continued vomiting prohibit the use of milk by the mouth, I resort to rectal alimentation early, and particularly in children. Certain symptoms, as *nausea*, *pain*, and *restlessness*, demand as early relief as possible, and can be most successfully met by the use of morphin in small doses hypodermically at intervals of twelve hours. When constant nausea is the symptom chiefly complained of, I have found creasote combined with bismuth or cocain in small doses to be highly serviceable. Convalescence is usually uninterrupted, and is soon complete. When protracted it is often on account of the too early return to solid articles of diet or the too early use of bitter tonics. The mineral acids should first be administered, well diluted, after the local symptoms have in a great measure subsided, and to these the bitter vegetable tonics are later to be gradually added. Locally, I employ sinapisms at the beginning of severe types of the affection, and follow these with warm linseed poultices lightly applied to the entire epigastric and hypochondriac regions.

TOXIC GASTRITIS

Pathology and Etiology.—This is an intense form of acute gastritis, produced by the ingestion of irritant and corrosive poisons, among the former being such agents as phosphorus, antimony, and arsenic, and among the latter concentrated mineral acids and strong alkalies. When caused by the non-corrosive poisons, intense hyperemia and tumefaction, leading to desquamative changes in the glandular structure, ensue. When excited by corrosive

CHRONIC CATARRHAL GASTRITIS

(Chronic Catarrh of the Stomach; Chronic Catarrhal Dyspepsia)

Definition.—A chronic catarrhal inflammation of the gastric mucous membrane, presenting various degrees of intensity and embracing the symptoms that are more or less characteristic of widely different clinical forms of gastric derangement.

Pathology.—The anatomic changes are most marked near the pylorus, where the mucous membrane often presents a distinctly wrinkled, mammillated appearance. The mucous membrane looks either red or gray (the latter hue being due to pigmentation), and is pretty generally covered by tenacious mucus, mingled with detached epithelium. Ewald describes the histologic changes thus: "The minute anatomy shows the picture of a parenchymatous and an interstitial inflammation. The gland-cells are in part eroded or show cloudy, granular swelling or atrophy. The distinction between the 'haupt' and 'beleg' cells cannot be recognized, and in many places, particularly in the pyloric region, the tubes have lost their regular form and show in many places an atypical branching like the fingers of a glove. Individual glands are cut off toward the fundus, but appear at the border of the submucosa as cysts, with a smooth membrane, partly filled with remnants of hyaline and refractile epithelium. An abundant small-celled infiltration presses apart the tubules, and is particularly marked toward the surface of the mucosa, and from the submucosa extensions of the connective tissue may be seen passing between the glands. The muroid transformation of the cells of the tubules is a striking feature in the process and may extend to the very fundus of the glands." Hemorrhagic abrasions and superficial ulcers in the pyloric region may be found in cases due to cardiac disease or to portal engorgement. Long-standing cases also present sclerotic changes of the mucous membrane. Of these, two forms are distinguished. In the one variety the mucous membrane is smooth and atrophied; the glands are narrowed and shortened, while the gap thus formed is filled with connective tissue. There is a thinning of the stomach-wall, with enlargement of its cavity. The other form presents a hyperplasia of the mucosa, the glandular structure, and the submucous layer, sometimes resulting in enormous thickening of the stomach walls, with great diminution in the size of its cavity (*gastrophthisis*).

Etiology.—The causes of chronic gastritis act either as mechanical, chemical, thermic, or biologic irritants, and fall naturally into the following classes: (a) Errors of diet (referring more particularly to important articles of food), of variety, and preparation; excessive alimentation, the habit of eating at irregular intervals or with undue haste, and thus not allowing time for perfect mastication of the food. The too free use of ice-water, tea, and coffee during meals play an important rôle in the causation of dyspepsia in America. Man-^{at} believes that the habit of taking beverages and food too hot for the tissues to bear without injury is the cause of a large proportion of cases. (b) The moderate use of alcohol, more particularly spirituous liquors, stands second in order of importance. Those persons who habitually indulge in alcoholic beverages to excess are prone to an irregular mode of life, which leads to digestive disturbances. Such patients are apt to suffer from the more active forms of the complaint, and, at intervals, from genuine acute gastritis. In the same category should be mentioned certain toxic irritants, as the overuse of tobacco and the prolonged use of tonics and purgatives. (c) Functional derangements of the stomach sometimes merge into the disease under consideration. This is true of that form in which there is a deficiency in the gastric juice. Stockton holds that the majority of cases of chronic dyspepsia are of

¹ *Jour. Méd.*, Paris, 1917, xxxv, 133.

d with the food, and that certain of them contribute toward the production of gases, and of the organic acids of the stomach. Hydrochloric acid favors the development of bacteria.

Microscopical examination of the contents of the stomach for purposes of diagnosis according to the methods laid down in the preliminary section (49) should not be neglected. In simple chronic gastric catarrh the hydrochloric acid is found to be diminished, and lactic, butyric, and acetic acids are rarely present. In many cases of chronic catarrhal gastritis there is an abundance of mucus (*gastritis mucipara*—Boas); and in other cases there is a normal amount of acid or even hyperacidity—the *gastritis acidula*.

Loeper and Verpy observed 72 cases of this type among 135 cases of chronic gastritis in soldiers. In protracted forms free HCl is sometimes greatly diminished or entirely absent—*gastritis anacida*. According to Boas the difference between the atrophic form is but one of degree, all secretion being lost in the latter.

In atrophic gastritis then there is little or no mucus in the gastric contents and in established cases an absence of HCl and of the gastric ferments (atrophic gastritis).

Pilcher states that absence of HCl is often associated with the presence of occult blood in chronic gastritis, most commonly when the condition is secondary to disease of the gall-bladder, appendix or pancreas.

Boas subdivided all cases into three varieties: (a) *Simple gastritis*, in which the fasting stomach contains only a small quantity of slimy fluid, while after test-breakfast the HCl is diminished in quantity, and lactic acid and fatty acids are usually present. (b) *Mucous gastritis*, in which class the condition is always slight and the condition is distinguished from simple gastritis by a large amount of mucus present. (c) *Atrophy*. Here the fasting stomach is always empty, while after test-breakfast HCl, pepsin, and rennin are wanting.

Van Leersum¹ has described an exfoliating gastritis, in which large masses of mucosa are found in the stomach contents and wash water.

Physical Signs.—Sometimes there may be observed an undue distention of the stomach, the prominence being more marked toward the left. On firm pressure over the epigastric region tenderness is often elicited. It is not present in the early stages, nor constantly later, since the degree of inflammatory action is subject to great oscillation. Diffuse tenderness in the epigastric region is of great diagnostic value. It is to be recollected, however, that resistance may be felt when the stomach is thickened in chronic catarrhal gastritis. Dilatation of the organ may be indicated by splashing—(see *Physical Signs*, p. 757), but these are not suggestive of gastritis unless at a time when the stomach should be empty.

On percussion we may note alterations in the size of the organ.

Among the general symptoms manifested the *nervous phenomena* are of great importance. The nervous derangements have been by many writers attributed solely to morbid sympathetic disturbances. We should, however, bear in mind the share of the morbid influence to the absorption of toxic materials from the stomach and intestines. Headache is frequently complained of; it is usually frontal, though also occipital, and tends to appear before meals. The so-called sick headache more rarely occurs. Indisposition to mental exertion, vertigo, depression of spirits, and well-marked hypochondria are common concomitants. Patients complain of wakefulness at night, disturbed dreams, though drowsy after meal-time. There is a sympathetic disturbance of the cardiac rhythm, and sometimes dyspnea, owing to the same cause. The urine is often highly colored, scanty, and occasionally it is of low specific gravity, rather copious in amount and pale in color.

Complications.—The intestines often become involved, and usually in the form of catarrh or extension. Implication of the duodenum may lead to jaundice.

¹ *Nederlandsch Tijdschrift voor Geneeskunde*, May 6, 1916.

and to obstinate constipation, though only moderate constipation is the rule in catarrh of the stomach. When the process extends to the large intestines diarrhea develops. Although diarrhea may be present at any time owing to the relaxed pylorus (from absence of free HCl) which permits (1) large quantities of poorly masticated food to pass into the intestine and irritate it mechanically and (2) excessive bacterial activity in the intestines from the bacteria, which under ordinary circumstances taken in with the food are destroyed by the free HCl of the stomach. The nutritive system is, in confirmed cases, seriously implicated in examples of combined intestinal and gastric catarrh, as shown by the anemia, emaciation, and general debility present. The gases generated in the stomach often find their way into the intestinal canal, giving rise to distention, and sometimes to colicky pain. Perhaps many reflex sympathetic disturbances are of intestinal origin. The gastric catarrh may extend upward to the oral cavity. Under such circumstances the tongue is large and heavily coated, with impressions of the teeth upon its edges. The abnormal condition of the secretions renders the breath foul and causes thirst. Certain skin eruptions, as eczema, lichen, and urticaria, are common. These disorders of the skin are probably due to a protein intoxication from the intestinal tract. I have frequently observed, however, that when present their improvement has been followed by an aggravation of the gastric symptoms, and *vice versa*. A sequel of the disease is dilatation of the stomach. The course of chronic gastric catarrh is long, the average duration being considerably more than one year. Its duration may be much abridged by early recognition and proper treatment. The symptoms at first remit, but later are persistent.

Diagnosis.—A positive diagnosis may be based on a clear etiology, the presence of persistent symptoms and signs of digestive disturbance, diminished (*usually*), normal, or even increased, amount of HCl (the atrophic form apart, *vide supra*), an abundance of mucus in the gastric contents, and deficient absorptive power with hypermotility. The finding of mucus in the wash-water of the fasting stomach is truly diagnostic (Riegel). The points of difference between the more serious affections of the stomach (carcinoma, ulcer, and dilatation) and chronic gastric catarrh will be detailed when the former diseases are considered. As I have said, Ewald makes three leading forms of the complaint, based on the results obtained from an analysis of the stomach-contents, but transitional types are constantly met with.

Prognosis.—Chronic catarrh of the stomach may be said not to manifest an innate lethal tendency. It, however, aggravates the symptoms of existing forms of acute and serious forms of chronic diseases, especially other organic affections of the stomach. The prognosis depends considerably upon the stage that has been reached when first met with, since the condition is amenable to treatment only when not too far advanced. The prognosis is rendered somewhat more grave by the presence of certain complications, particularly intestinal involvement. I have seen one case that proved fatal in consequence of stricture of the pylorus.

Treatment.—It must never be forgotten as far as possible to search for and remove the causal affections in every case. When associated with grave forms of cardiac, hepatic, or renal disease these must receive careful attention primarily.

The masticating apparatus must be looked after by the physician, who must also instruct his patient in the art of eating slowly, so that insalivation of the food is thoroughly effected. Too often the quantity of aliment consumed is beyond the need of the bodily functions, and the method of preparing the same faulty. All food eaten should be fresh and pure. Such patients should eat oftener than in health, taking four or five meals in the twenty-four hours. The physician must with untiring diligence attend to every dietetic

, and therapeutic detail. The major portion of the treatment has to—

The Diet.—In the matter of arranging the dietary in separate cases the condition and peculiarities of the individual must be taken into account. The wise physician will be guided to some extent by the dictates of his experience, and will not fail to avail himself of any information available upon this head. The teachings of physiology direct that animal food should be allowed with a view to stimulating the secretion of HCl when it is deficient in the gastric contents. We must, however, select the species of diet according to the severity and nature of the morbid process. In some cases an exclusive milk diet for a period of two to four weeks often gives the best results. The daily amount requisite to meet the caloric needs of the individual is about 1500 c.c. Of this, 120 to 200 c.c. are to be taken *slowly* two hours during the day. The beginning amount, however, must usually be smaller—to be gradually increased. A pinch of salt or from 1 to 2 c.c. of lime-water may be added to each feeding, or the milk may be mixed with Vichy. The milk should not be taken iced, but warmed or at the temperature of the room. Boiled milk is objectionable. The stools must be watched for curds, and when the digestive capacity is exceeded the quantity of the nutrient should be lessened and other articles cautiously added. In some cases whole milk cannot be digested on account of an actual loathing for it; in such cases creamed or partly skimmed milk or buttermilk should be substituted. If milk cannot be utilized in proper amount, animal broths, together with some of the artificial foods, may be added. As tolerance for a liberal quantity of milk becomes established the appetite is no longer satisfied, and then to add the light solids in a gradual manner; for example, white meat of chicken or game (except tame ducks and turkey), stale or twice-baked bread, dry-toast or zwieback, soft-boiled eggs, oysters, fish, and, later, Ham-broths, stewed sweetbread, and the like. For dessert, junket or custards, mixed with saccharin, are well borne as a rule. Subsequently, farinaceous foods, if thoroughly cooked (except oatmeal), and certain plain vegetables, may be allowed, but their effects must be minutely observed. The former are best chewed in cases in which acid-fermentation or flatulency is a prominent feature. Among the latter, rice, spinach, lettuce, and macaroni (stewed in milk) are to be selected. Peas and beans, if green and succulent, may be eaten, but if overripe are to be discarded. The only form of fat permissible is butter. Stewed fruits, graham bread, and soft, green vegetables are often well borne and tend to overcome constipation. Pig's- and calf's-foot jelly are also allowed.

In light cases and in those of moderate severity, particularly if the cause of the complaint is removable, the dietary need not be rigid at the start. Indeed, to minimize the saccharine articles and starches and to avoid the coarser articles, hot bread, pastries, and the like, is all that is required. In the case of confirmed dyspeptics the following articles are to be scrupulously avoided: very fat meats, fat fish-foods, condiments, certain fruits (strawberries, raspberries, etc.), hot bread, saccharine articles of diet and farinacea, potatoes, and green vegetables. Fermentable foods, as milk, eggs, and rare meats, should be avoided in selected cases.

The best drink during mealtime is simple hot water, to which a little milk may be added, or a single coffee-cup of weak tea. Occasionally cocoa is allowed, but ordinary chocolate, coffee, and strong tea are harmful. Too much liquid should not be taken during a meal, since it dilutes the gastric juice to a deleterious extent, and cold drinks are to be interdicted during the acute period. Alcohol, and particularly concentrated spirituous liquors, have a very irritating effect, and hence should be forbidden. In cases in which

there is no gastric fermentation certain wines may be allowed (Oporto, Malaga, imported Hungarian Tokay).

(2) *Hygienic measures* are of signal value in this disease. Of these the most important are forms of fresh-air exercise, as bicycling, walking, boating, and horseback-riding. Open-air exercise may be supplemented by suitable indoor apparatus. Physical exercise must be carefully supervised, so as to avoid the deleterious effects of overexertion. I am convinced of the superior advantage of travel, including a sea-voage, and an appropriate change of air—for example, to the seaside or mountains—particularly for the large class of self-centered and low-spirited dyspeptic patients. A cold sponge-bath, followed by brisk friction of the skin, is to be advised. An abdominal bandage, made of woolen or silk material and constantly worn, tends to increase the patient's comfort.

(3) *Medicinal Treatment*.—Saline laxatives, as sodium phosphate, Rochelle salts or Carlsbad salts, taken fasting in hot water, are advantageous, since they serve to regulate the bowels, to deplete the engorged gastro-intestinal vessels, as well as to rinse the stomach. Hunyadi Janos or Carlsbad water may be substituted. Their efficacy is much enhanced when the alkaline carbonates are administered simultaneously. Patients may be advised to seek suitable watering-places, but the course should not be for too long a period. The use internally of antiseptics, combined with alteratives and mild astringents, is often beneficial. I can speak most positively in favor of the following pill:

R. Argenti nitratis, gr. iv (0.25);
Ext. hyoscyami, gr. viij (0.5);
Bismuthi subnit., gr. xxxij (2.100).

M. et ft. cap. No. xvj.

Sig. One a half hour before meals.

The stomach should be prepared for the above capsule by washing with one or more pints of a 2 per cent. solution of borax in water. Hemmeter recommends silver nitrate, in the form of lavage (1 : 2000), or in the form of solution 0.3 to 120 of peppermint-water; of this one tablespoonful three times daily on an empty stomach.

In the *fermentative* form of chronic gastric catarrh the hyperacidity is, in reality, often dependent upon the lack of free HCl; hence this agent should be supplied. It is best administered immediately after meals, the dose being not less than 10 minims (0.6), well diluted, and this may be repeated in the course of ten or fifteen minutes in obstinate cases; it may be combined advantageously with pepsin (gr. v to x—0.3–0.6) in those forms of gastritis in which both the free HCl and digestive ferments are either much diminished (mucous variety), or absent (atrophic variety). This remedy is rarely indicated in simple chronic gastritis. Pancreatin is better associated with sodium bicarbonate in the form of a tablet containing each gr. ij (0.13). Of these two or three may be administered fifteen to thirty minutes after meal-time. Care is to be taken to use only the best articles of pepsin and pancreatin. This class of cases represents an aggravated or advanced form of the disease (atrophic stage), and demands prolonged and varied treatment. At the end of the digestive process it is well to irrigate the stomach (lavage) if evidences of dilatation be present. The stomach may also be cleansed and prepared for the reception of the next meal in a very agreeable manner by having the patient sip a 2 per cent. solution of borax in warm water or a 2 per cent. solution of sodium chlorid half an hour before meals; indeed, the continued use of simple hot water for the same purpose has, in my hands, often given excellent results. With it must, of course, be combined the saline laxatives and the restricted diet. Not less than 1 pint of water, hot as it can be taken

the patient, should be sipped at each sitting. Boas considers magnesium sulfate (gr. xv to xxx—1.0–2.0, t. i. d.) the best antifermentative remedy. To assist the appetites of these patients and to stimulate the secretory function a few drops (not more than 5) of the tincture of nux vomica may be taken fifteen minutes before meals, with gr. ii to iij (0.13–0.19) of sodium bicarbonate. These indications are also fulfilled by lavage once daily or twice daily (if the patient be feeble). If hyperacidity, due to the organic cause, tends to persist, we may combine bismuth subnitrate with magnesia and a few grains of charcoal, this being administered when the stomach is empty. We may also check fermentation by the exhibition of salicylic acid (gr. v—0.3) thrice daily or creasote (gr. $\frac{1}{2}$ —0.03) thrice daily. Germain Sée recently found strontium bromide (3ss to 3j—2.0–4.0) to be of great value in cases in which gaseous fermentation with hyperacidity is combined with permanent tenderness. In chronic gastritis with hyperchlorhydria highly restricted diet is recommended, as it tends to reduce gastric secretion. Happy patients often follow a course at some spa if the patient be under the charge of a competent physician during his sojourn. The robust or plethoric should go to Vichy or Chatelguyon abroad, and to Saratoga at home, using more especially the Hawthorne water. The anemic should go to the iron springs at Bedford, Pennsylvania. A course of the alkaline mineral waters may be successfully taken at home in many instances, though patients are much more apt to obey the physician's injunctions as to diet, exercise, and the like when at a spa than when at home. These waters do not simply act as purgatives, but also as antacids. It has been experimentally shown that sodium chloride, sodium carbonate, as well as carbon dioxide, promote the secretion of the gastric juice. In the more chronic cases belonging to this class or those that have resisted other forms of treatment intestinal complications are usually avoided. Here the alkaline waters are to be alternated with calomel in small doses, prescribed thus:

R.	Hydrarg. chloridi mitis,	gr. ij (0.13);
	Sodii bicarb.,	3j (4.00);
	Sacchari lactis,	3ss (2.00).
M. et ft. chart. No. xij.		
Sig. One four times daily.		

If the patient has been in the habit of continuing the use of these powders for one week, he should return to the alkaline waters for two weeks.

In the *mucous* variety of gastric catarrh additional indications for treatment are presented. The chief aim should be to limit, as far as possible, the action of mucus and to cleanse thoroughly the stomach prior to each meal, preparing the organ for the reception and better digestion of food. Here, at least one pint of hot water, containing the substances before mentioned, should be sipped half an hour before each meal. This mode of cleansing the stomach is usually successful; if unsuccessful, however, it should be supplemented by lavage once daily, employing two or more pints of warm water. The siphon is also quite useful in cases of this sort in which stricture of the pylorus is suspected and when the food is retained in the stomach much longer than the normal period of digestion; a condition which is enhanced by the mucus collecting upon the food and thus preventing it from being acted upon by the gastric juice. For the same reason absorption is greatly retarded. The therapy of this form of chronic gastritis requires the more potent astringents for the purpose of arresting hypersecretion of mucus. The best way to use these agents is topically. The stomach may be washed (at bed-time or early in the morning) with a 2 per cent. solution of alum or a 1 per cent. solution of acetic acid; antiseptic solutions are employed in like manner, a 2 per cent.

perated upon up to July 1, 1915 for peptic ulcer, 27 per cent. were in the stomach and 73 per cent. were duodenal.

The deeper ulcers heal by cicatrization. The resulting scar is pale and tellate, and there is puckering of the surrounding mucous membrane. If the ulcer has not extended deeper than the mucous membrane, granulation-tissue develops from the edges and base; this tissue slowly contracts, uniting the margins without a distinct scar. On the other hand, if the ulcer be large and involve the muscular and serous coats, stricture of the pylorus, followed by dilatation, may result. The stomach may present an hour-glass shape, due to the contraction of a girdle ulcer in the central part of the organ. Nearly all peptic ulcers would perforate the coats were it not for the development of a localized peritonitis with the establishment of protective adhesions. The ulcers being usually situated on the posterior wall, the surface of the pancreas forms the point of attachment most frequently, though the stomach may also become adherent to the left lobe of the liver, the spleen, omentum, diaphragm, or the transverse colon. The organs with which the stomach becomes agglutinated may be penetrated by the ulcerative process, resulting in suppurative inflammation (*abscess*); or, guided by the limiting adhesions, fistulous connections of the stomach with the transverse colon, the pleura, the pericardium, lungs, gall-bladder, and the duodenum may be established. Of these, gastro-colic fistulæ are the most common. The ulcer has perforated the left ventricle. Penetration of the ulcer through the posterior gastric wall opens the lesser peritoneal cavity, in which case the base remains limited, producing a condition known as subphrenic pyopneumothorax. When the anterior surface of the stomach, which has no anatomic relations with other organs favorable for the establishment of protective adhesions is perforated, general infectious peritonitis rapidly supervenes. Intense hyperemia or the erosion of small vessels gives rise to small or moderate hemorrhages. If the ulcer penetrate one of the larger vessels, then fatal hematemesis is the usual result. The development of a "protective thrombosis" may prevent this accident. In several instances small aneurysms have been found at the bases of the ulcers (Douglas, Powell, Welch).

Frequency and Etiology.—The prevalence of gastric ulcer in the various countries is shown by the statistics of C. P. Howard; he analyzed the records of 161,599 cases treated in American hospitals, and found 930 instances in which gastric ulcer was present (0.57 per cent.); Bromwell, of Edinburgh, in 43,357 cases, found 2.02 per cent. to suffer from gastric ulcer. The percentage for London is 1.24 per cent. lower than that given for Edinburgh; Breslau 0.66 per cent.; Berlin 1.33 per cent. Concerning its pathogenesis, there are two points that are generally accepted: (a) that the ulcer is due to a self-digestion of a circumscribed portion of the stomach; (b) that the resistance of the part digested has been previously reduced or even lost. Diminished or lost resistance may be due to a lessening of the supply of alkaline arterial blood, which prevents the stomach from being digested in health; also, to *embolism* and *thrombosis* of the nutrient artery of the part, the infarct thus produced being annihilated by the gastric secretions (Virchow). W. and E. L. Burge ascribe the digestive action of gastric juice to a decrease in the oxidative processes of the cells of the part. Bassler thinks the lack of gastric mucus, which protects the glandular elements in hyperchlorhydria, is a factor. Stockton holds that the disease is of nervous origin. Traumatic injuries have been suggested. Says Lichty,¹ the theory most accepted is probably lowered vitality, localized traumatism, and increased or changed

¹ "Some Clinical Aspects of Gastric Hemorrhage," *Amer. Jour. Med. Sci.*, November, 1914, p. 680.

cramps to be more intense than do less irritating articles of diet. *Rest* diminishes the pain by preventing traction on the ulcer. *Certain postures* aggravate it, and, while not a trustworthy guide, we may often determine the situation of the ulcer by the effect of posture after taking solid food. The severity of the pain is often increased by bodily fatigue or even moderate exercise and emotional influences. The situation of the pain, when strictly localized, is of the utmost importance in diagnosis. I have found it almost invariably from one to two inches below the ensiform cartilage, yet it has also been observed in the umbilical and hypochondriac regions. It is absent in one-half of all cases. There is a pain-point in the dorsal region (often at the level with the tenth to the twelfth thoracic vertebra) on the left side. Says Killian: One special symptom that indicates the spread of ulceration is persistent cutaneous hyperesthesia in Head's epigastric triangle and at the dorsal pain-point.

Vomiting, next to pain, is the most frequent symptom, but unless the vomitus contains macroscopic blood, which is present in less than 50 per cent. of all the cases, or occult blood (*vide* p. 799), it has little diagnostic importance. Nausea and eructations of acid or food often precede or accompany the emesis. Vomiting usually occurs about two hours after eating, often at the height of a paroxysm of pain, which the vomiting relieves as a rule. The *vomit* contains *gastric contents*, as first shown by Riegel, commonly contains an increased portion of HCl (hyperacidity) in 90 per cent. of the more acute forms, though many cases of ulcer are found without secretory disturbances. The gastric acidity is abnormally high. The withdrawn test-meal usually contains blood, either macroscopic or occult. The acidity is reduced with the age of the patient and chronicity. Kemp confirms Rubow's assertion that the amount of residue is large and extremely acid.

Hematemesis is a symptom of unequalled clinical significance, and on a single occasion frequently rests a positive diagnosis. When the hemorrhage is considerable, pure blood, more or less clotted, may be ejected, this being highly characteristic of gastric ulcer. Frequently, however, the blood oozes gradually from the stomach and mingles with the gastric juice, and in consequence the hemoglobin of the blood is converted into hematin, the vomitus presenting the appearance of coffee-grounds. On *microscopic examination* large and small masses of blood-pigment are seen, but the red cells are incapable of recognition.¹ Vomiting of blood may occur at intervals of a few hours or on each successive day. The *amount* also varies within the widest limits according to the size of the vessel eroded. Some of the effused blood passes through the anus, escaping with the feces and giving to the latter a tarry, black appearance. In duodenal ulcer the blood is usually evacuated with the stools except in cases in which it was absorbed from the alimentary tract. Steele claims that gastric ulcers do not bleed as often as might be expected, and that in dubious cases the stools must be examined for several weeks for occult bleeding before chronicity could be excluded. Einhorn² has used his string test for many years, and gives it to be of great value not only in determining if hemorrhage is present but also where the bleeding point is situated. *Intermittent* occult hemorrhages, however, generally occur, pointing strongly toward ulcer. Either as the result of a single copious hemorrhage or of repeated smaller bleedings a *pronounced anemia* is produced. The profound shock may result from profuse hemorrhage. As a rule, however, the evidences of anemia are only moderately well marked, and to assume that the anemia is due solely to the hemorrhages would be an error. A slight rise of temperature is often observed under these circumstances;

¹ The blood, however, can be identified by the guaiacum and other chemical tests through its spectroscopic appearance.

² *Jour. Amer. Med. Assoc.*, 1919, lxxiii, 1509.

irring with gastralgie attacks are almost pathognomonic. A considerable portion, however, offer formidable difficulties. In the absence of hemorrhage we may infer the altogether probable existence of ulcer if there be a story of the more important etiologic factors; if there be pains at a definite site, hyperacidity, localized tenderness, a dorsal pain-point; and, particularly, if the latter symptoms be aggravated by the taking of food. The Einhorning-test and that for occult blood in the stomach contents and feces are useful aids, while the long course and liability to remission are also strongly confirmatory. Roentgen-ray examination of the stomach and duodenum is an extremely valuable aid in arriving at a diagnosis, but it should not be forgotten that the absence of typical roentgenologic findings does not, by any means, preclude the possibility of ulcer being present. The most typical positive finding is the shadow of the ulcer. Failing this, other suggestive findings include increased gastric peristalsis, pylorospasm or spasm of the muscle of the area corresponding to the location of the ulcer, the so-called duodenal spasm, early hypermotility, particularly in duodenal ulcer, and so on. Baetjer and Friedenwald¹ call attention to the fact that in addition to a filling defect there is a preliminary quick expulsion of the gastric contents, followed by spasticity with hour-glass contraction and a retention of from four to six hours. Chronic ulcers may produce deformity of the stomach wall by cicatricial contraction.

Differential Diagnosis.—This disease may be mistaken for *gastralgia*, *chronic gastritis*, *the passage of gall-stones*, *cirrhosis of the liver*, and *carcinoma of the stomach*. The differentiation of the latter complaint will be given later. In certain cases of cirrhosis of the liver hematemesis is met with, but here there is absence of all the other characteristic symptoms of ulcer, and the presence of a group of symptoms and physical signs pointing to disease of the liver. Hepatic colic simulates ulcer of the stomach without hemorrhage. The sudden onset, the longer duration of the attack of pain, its sudden complete cessation, the presence of jaundice and certain physical signs presented by the abdomen, often suffice to distinguish this affection from gastric ulcer. The urine usually contains pepsin in ulcer, and the administration of orthoform (Hemmeter) will relieve the gastric pain but not that of cholelithiasis. (c) Chronic gastric catarrh with hematemesis resembles ulcer of the stomach in many particulars. The great diminution in the proportionate amount of hydrochloric acid found in chronic gastric catarrh and the increased amount in gastric ulcer help materially in discriminating these two diseases. When associated with one another, observation teaches that there is an excess of HCl present; hence a proportionately diminished amount of HCl probably argues against the presence of ulcer. The vomiting in ulcer is combined with severe paroxysms of pain; so in chronic gastritis, and the vomit in the former contains larger quantities of blood than in the latter disease. (d) Doubtless ulcer of the stomach has not been mistaken for neurotic gastralgia and the discrimination cannot always be accomplished to a certainty.

GASTRIC ULCER

History unimportant.
Onset frequent from fifteen to thirty-five years of age.
Paroxysms of pain usually come on at a definite period after eating.
Eating rarely relieves pain.
Rest of patient may relieve pain.

GASTRALGIA

History of neurasthenia, neuralgia, and hysteria the rule.
Most frequent before or near the menopause (in the female).
Paroxysms more frequent when stomach is empty and show less periodicity.
Eating usually brings relief.
No decided relief.

¹ *Bull. Johns Hopkins Hosp.*, 1918, xxix, 177.

uld also be carried out. Transfusion should be done as soon as there are indications for it. Bastedo,¹ in addition to the above, recommends, to prevent recurrence, the subcutaneous injection of 10 to 50 c.c. of horse blood-serum every six to twelve hours, or a single injection of 100 to 500 c.c. of human serum, intramuscular injections of coagulen, kephalin, or thromboplastin.

Operative intervention in gastric ulcer is demanded: 1. In recurring hematemesis W. L. Rodman advises operation between attacks—always after the third bleeding. 2. In perforation, so soon as the diagnosis is clearly established. In the cases of perforation which have been operated upon within the last twelve hours during the past three years, 83.78 per cent. have been cured (Tinker). 3. Most of the cases not cured by medical treatment are curable by timely surgical intervention, but in simple ulcer of the stomach operation is not advised, "the medical treatment of which should be more careful and more prolonged than was formerly deemed necessary" (Robson). If gastrectasis due to pyloric obstruction or if adhesions form and persist, operation is indicated. The treatment of callous ulcer is purely surgical.

CARCINOMA OF THE STOMACH

Pathology.—Next to the uterus, the stomach is the most favored seat of carcinoma. In a total of over 30,000 cases studied by Welch, 21.4 per cent. showed involvement of this organ. With reference to the parts of the organ attacked, Welch analyzed 1200 cases with the following results: pyloric region, 11; lesser curvature, 148; cardia, 104; posterior wall, 68; greater curvature, 1; anterior wall, 30; fundus, 19. The forms of gastric carcinoma noted are columnar epithelial (including colloid) and the glandular carcinomata (embracing encephaloid and scirrhus). The epitheliomata grow from the lining epithelium, while the encephaloid and scirrhus are new growths from the glandular epithelium. The last two forms are, therefore, similar in structure, but differ in the rapidity of their growth; the encephaloid cancers are soft, and readily break down on their surface, forming large ulcers that have a shallow floor, while the scirrhus cancers are hard and firm. Columnar epitheliomata are frequent, and are situated at the pyloric end of the stomach. They are often the seat of colloid degeneration. Squamous epitheliomata occur at the cardiac end. Secondary new growths in adjacent organs occur, scirrhus, however, manifesting the least tendency to metastasis. Perforation of the stomach-walls occurs in 3.3 per cent. (Brinton). Welch collected 37 cases of secondary gastric carcinoma; 17 were secondary to mammary carcinoma. Atrophic gastritis ensues.

Etiology.—The factors bearing upon the etiology of gastric carcinoma may all be regarded as **predisposing causes**. Of these *age* is the most potent. In 2038 cases examined by Welch with reference to this point, 75 per cent. occurred between the fortieth and seventieth years, 24.5 per cent. between thirty and fifty years, 30.4 per cent. between fifty and sixty years, and 2.8 per cent. before the thirtieth year. The maximum liability lies between the forty-fifth and sixtieth years (Lebert). In 1069 cases collected by Osler and McCrae, 10 per cent. developed before thirty years of age. Smithies found a percentage of 2.2. under thirty years of age among a group of 721 consecutive cases examined by a uniform method. There are records of 6 cases before the tenth year. Collingsworth reports the case of a child at ten days and death at twenty-ninth day; and Widerhofer 1 at sixteen days. I find records of

¹ *Amer. Jour. Med. Sci.*, 1919, clvii, 99.

in the grasp. Boas contends that enlargement of the supraclavicular glands is not observed in the early stages.

General Symptoms.—Quite early in the disease such evidences of general nutritional disturbance as loss of flesh and anemia may be observed, and, obviously, cases attended with constant anorexia and vomiting will earliest manifest the wasting process. Almost from the beginning the face gradually assumes the cachectic appearance which, in the advanced stages, becomes so characteristic of gastric carcinoma. Anemia (*secondary*) soon becomes a prominent feature. There is a waxy pallor of countenance, and the peculiar cardiac murmurs of anemia appear. The blood frequently presents peculiarities that bear a resemblance to those seen in pernicious anemia, and at times such bloods are indistinguishable from those of true pernicious anemia. I have observed leukocytosis late during the course of this malady. A differential study of the leukocytes is of no value, and the presence or *absence of digestive leukocytosis* is too uncertain to be of diagnostic importance. Nucleated red cells (normoblasts) are not uncommon, and myelocytes are occasional findings. If the monocytes show ameboid nuclei, the case is almost certainly one of malignant disease (Gruner). The anemia of cancer is accompanied by loss of flesh, while in pernicious anemia the superficial fat is preserved. The causes of the profound anemia met with in this affection are not quite plain, since frequently it becomes pronounced before the nutritional disturbances (shown by a loss of flesh) have become marked. The fact that metastatic carcinoma has been found to be abundant in the marrow of the bones is significant in this connection, as pointing to the probable interference, in some instances, with the blood-producing function of the bone-marrow. In advanced cases moderate *edema* of the ankles and of the backs of the hands is frequently observed, and is probably dependent upon excessive anemia. The *temperature* at first shows no abnormalities, as a rule, though after the cachexia has become decided it is often subnormal. Sudden elevations of temperature (103° to 104° F.—39.4°–40° C.), preceded by rigors and followed by profuse sweating, are rarely observed. Giordano found that it was evident in 60 per cent. of 100 cases of cancer. The mind almost invariably remains clear to the last, though delirium may be a late-appearing symptom.

Complications.—*Intestinal symptoms* are frequently observed, and *constipation* in particular is quite common. It is apt to alternate with *diarrhea* toward the close of the disease, or diarrhea may in the later stages become a persistent and obstinate symptom. Some of the complicating conditions have reference to the *secondary* new growths. When, as frequently happens, the liver is implicated, *jaundice* is rather common, being associated with signs of hepatic enlargement. Indeed, so prominent may be the symptoms and physical signs referable to secondary carcinoma of the liver as entirely to mask the more or less hidden forms of carcinoma of the stomach. The mesenteric and retroperitoneal lymph-glands or the lungs may be the seat of secondary carcinoma, which, however, rarely gives rise to characteristic symptoms. Occasionally the new growths spread to the peritoneum (and excite exudation) or to the rectum. Perforation may rarely occur, and we then have the pronounced and rapidly supervening symptoms of diffuse peritonitis. Friedenwald and McGlaunan¹ report 4 cases of perforation of cancer, all of which terminated fatally in a short time. *Fistulous communications* between the stomach and the transverse colon or the small intestine—the latter rarely—may also occur. *Nervous symptoms* may be regarded as complicating conditions, and sometimes hasten the fatal termination; the patient be-

¹ *Amer. Jour. Med. Sci.*, 1919, clvii, 1.

comes somnolent or, rarely, even comatose; the breathing is difficult and the respiration deep and labored. This mode of termination I noted in one case. Traces of *albumin*, and in the later stages tube-casts, may be present in the urine. Indicanuria is a rather common symptom, while acetoneuria is seldom seen. Diacetic acid is present in rare instances.

Latent Forms.—The disease may be latent, most often in feeble persons and in the aged, and accidentally discovered on physical examination. In some cases the cachexia furnishes ground for suspicion.

General Course and Duration.—The course of gastric carcinoma is invariably toward a fatal issue, death usually taking place before the expiration of two years. The average duration of the disease is about one year. When it occurs in emaciated persons it pursues a slower course than when occurring in fleshy individuals. Cases develop only slowly in old ulcer cases. The younger the individual the more rapid the course of the disease. The symptoms are far less intense in the cases in which food stagnation is absent.

Diagnosis.—A positive diagnosis of gastric carcinoma is easily made when a tumor is demonstrable. The history, the presence of characteristic symptoms, such as pain, ectasy, coffee-ground vomit, deficient motor power (*early*), the constant absence of free hydrochloric acid, especially the almost constant presence of lactic acid after the Boas test-meal (unfortunately not an early feature) and a constant positive blood reaction in the stools, all occurring in persons beyond middle life, together with the existence of progressive cachexia, are sufficient to warrant a diagnosis in the absence of a palpable new growth. A putrid smelling tube and putrid eructations have diagnostic importance, and Hemmeter states that the early diagnosis of carcinoma of the stomach is possible in a certain number of cases from histologic examination of small fragments of gastric mucosa, if a direct invasion of the gland-substance by epithelial cells is observed. Carcinoma of the stomach in the late stages is usually diagnosed with ease. It is the early diagnosis, when operative procedures may cure the conditions, that is of primary importance. The case should be most carefully studied. The onset of gastric symptoms in a person over forty previously free from gastric symptoms, the history of an ulcer, evidences of impairment of motility, repeated finding of occult blood in the stool or other corroborative laboratory tests are extremely suspicious symptoms. Exploratory laparotomy may be advised if improvement does not follow medical treatment in suspicious cases within a few weeks at most. Moullin has emphasized the diagnostic value of direct inspection through an incision. Wolff and Junghans¹ first pointed out a special method for the estimation of the soluble albumin in the gastric extract and claimed it to be of value in the diagnosis of gastric carcinoma. Smithies, and Friedenwald and Kieffer² confirm this view, although it is only of significance when taken in connection with other signs. Kelling's method, or the hemolytic serum test, was applied by Rosenbaum in 70 patients, including 26 of carcinoma; he obtained favorable results. The meiotagmin reaction (Ascoli) has been found to be reliable by certain observers. The glycytryptophan test is valuable for diagnosis (Weinstein). Goodman's modification of the Salomon test, which shows the percentage of phosphates (over 10 mg. per 100 c.c.) in the wash-water, is corroborative in ulcerative cases. Falk and Salomon's salicylate method is of material aid.³ Salomon and Saxl⁴ have

¹ *Berliner klin. Wchnschr.*, May 29, 1911, and March 18, 1912; *Med. Klinik*, March 24, 1912.

² *Amer. Jour. Med. Sci.*, September, 1916, p. 321.

³ *Deutsche med. Woch.*, January 11, 1912.

⁴ *Arch. Inter. Med.*, October, 1912.

found a reaction of neutral sulphur in the urine very constant in carcinomatous patients. Smithies¹ found in 1175 cases this test less constant than the glycytryptophan reaction. A positive skin reaction is strong presumptive evidence of carcinoma (Lisser and Bloomfield).² B. K. Brown found the stools uniformly Gram-positive in a series of cases. An expert roentgen-ray examination is an important aid in the diagnosis. The roentgen study may show distinct alterations in the normal stomach outlines or there may be merely changes in the rhythmic peristaltic waves to suggest pathologic changes in the stomach-wall.

When malignant degeneration of an ulcer sets in, pain increases in intensity and may radiate to the thorax and back, anorexia develops, hyperacidity often gives way to achlorhydria, and hematemesis may occur early and recur at frequent intervals.

Differential Diagnosis.—A gastric carcinoma presenting a discernible mass is liable to be mistaken for a *cicatrizated ulcer*, for *carcinoma of the pancreas*, of the *transverse colon*, *duodenum*, *omentum*, and the *left lobe of the liver*, as well as for *aneurysm of the abdominal aorta*. The *aneurysmal tumor*, however, is smooth, and is not nodular, like the cancerous growth, moreover, it gives rise to an expansile impulse. In aneurysm the characteristic cachexia is wanting. In *pancreatic carcinoma* the tumor is fixed (*vide infra*, p. 914). *Carcinoma of the transverse colon and omentum* will be excluded by the presence in malignant disease of the stomach of a chocolate-colored appearance of the vomitus, deficient motility of the organ, the permanent absence of HCl, and persistent presence of lactic acid in the gastric contents. For the recognition of hidden gastric carcinoma with grave anemia the reader is referred to p. 456.

Chronic ulcer may in cicatrizing give rise to a small tumor, followed by pyloric stenosis and secondary dilatation—an exact counterpart of the course of gastric carcinoma. Great reliance should be placed on the age of the patient, the presence of HCl in the gastric secretions, the points of pain (dorsal epigastric and localized tenderness with hematemesis, and the longer duration of ulcer. Ulcer with tumor-like thickening may show an excess of lactic acid, due to associated motor insufficiency, rendering a differential diagnosis exceedingly difficult. Hypertrophic stenosis of the pylorus is also simulated (*vide p. 787*).

Simple gastric ulcer and chronic gastritis are often confounded with carcinoma of the stomach without palpable tumor (*vide parallel differential tables below, modified slightly from DaCosta*):

CHRONIC GASTRITIS	GASTRIC ULCER	GASTRIC CARCINOMA
Not confined to any age. More common in middle-aged or elderly people.	May occur in middle-aged persons, but is most frequent in young adults, especially women.	Most common in elderly people; rarely occurs in persons under thirty years of age.
Pain at the epigastrium somewhat augmented by food; soreness is also present. Both are constant, although comparatively slight.	Pain at the epigastrium much augmented by food; subsides when this is digested; paroxysms of pain, not lancinating; strictly localized soreness to touch in epigastrium; sometimes a painful spot over lower dorsal vertebræ. Intermissions in the pain are frequent.	Pain frequently of a radiating kind, often paroxysmal, not infrequently severe and lancinating, but not of necessity associated with soreness. Little or not at all affected by food. Pain rarely remits; never intermits for any considerable time.
Symptoms of indigestion marked.	Symptoms of indigestion sometimes very slight.	Symptoms of indigestion marked. Anorexia; extreme acidity of stomach.

¹ *Centralbl. f. die Grenzgeb. der med. und Chir.*, Jena, August 30, 1911.

² *Bull. Johns Hopkins Hospital*, December, 1912.

C GASTRITIS

GASTRIC ULCER

GASTRIC CARCINOMA

vomiting.	Vomiting may be present or absent.	Vomiting a very frequent symptom.
hage, or but tri- emorrhage; at lood-streaks in matter. stipated.	Abundant hemorrhage from the stomach common. Stools may contain blood (tarry). Bowels usually constipated; intermittent occult blood in stools. No fever.	Hemorrhage not very abundant, but frequently occasioning coffee-ground-looking vomit. Bowels obstinately constipated. Occult blood in feces continuously. Attacks of slight fever occur; temperature often subnormal.
emaciation; no appearance.	Acids taken increase pain. Frequently extreme pallor and debility, especially if preceded by anemia.	Not so. Progressive loss of flesh, and cachexia; enlarged lymphatic glands.
y be relieved or often of very ation.	Duration uncertain; may get well, may run on rapidly to perforation; or may last for years.	Average duration one year; may be shorter, but seldom longer.
of stomach al- ays contain free oric acid.	Rarely a tumor. Hydrochloric acid in excess in contents of stomach.	Generally a tumor. No hydrochloric acid in contents of stomach.
fatty acids after Boas test-meal. or disturbance.	No lactic or fatty acids after the rigid Boas test-meal. Motor function fair. No dropsy.	Lactic acid present after Boas test-meal. Early marked disturbance. Edema of ankles common.

ment.—The diet should be adapted to the peculiarities of the case. Physiology indicates that meat and meat-extracts stimulate ion of HCl, hence they deserve a careful trial in the earlier stages. ail of their physiologic effect, however, then articles of food that are and assimilated in the intestines should be employed. After well-vidences of pyloric obstruction appear we may add to the comfort ient by limiting the diet to liquids, and by predigesting them if they herwise well borne. Should the stomach reject all food, rectal ali- should be promptly instituted. The more troublesome symptoms omiting, hematemesis—are to be met on general principles. The at have been advanced in favor of arsenic and other preparations ing power to control the progress of gastric carcinoma await con-

If dilatation coexists, it is to be managed in accordance with the adations found under Dilatation of the Stomach (p. 759). Gastric is usually primary and for some length of time it is a local disease. gical intervention, therefore, offers promise of relief and even cure. ration, the use of radium may be tried for its prophylactic influence.

rtrophic Stenosis of the Pylorus.—By this term is meant pyloric n due to hypertrophy, principally of the circular layer of the muscu- i hyperplasia leading to secondary dilatation of the stomach. This z) congenital; (b) acquired (*e. g.*, tuberculosis). The *etiology* is un- lthough spasm of the pylorus has been suggested. The *symptoms* of dilatation of the stomach and a pyloric tumor may be palpable. bance to ulcer with tumor-like thickening and to *ulcus carcinomato-* be striking (*vide* also p. 786). The symptoms of the congenital form, to Binnie, are: 1. Explosive, expulsive vomiting with resultant n. 2. Visible gastric peristalsis. 3. Persistent constipation. 4. 5. Tumor, not always palpable. Roentgenology is valuable for in doubtful cases. Medical treatment—massage, electricity, lavage, asmodics internally—should be tried; this failing, pyloric stretching

To discriminate from this condition it is only necessary to make an examination of the lungs and elicit most carefully the history. It must also be recollected that *hysterical females* and *malingerers* have been known to swallow the blood of animals and other dark fluids, and vomit them subsequently. The vomitus may resemble dark blood in appearance when stained by bile or iron or after a free indulgence in wine. The points of contrast between hematemesis and *hemoptysis* are correlatively considered below:

HEMATEMESIS

The history points to gastric, splenic, hepatic, or cardiac disease, or anemia. A feeling of uneasiness, and sometimes of nausea or faintness, precedes the hemorrhage.

The blood is ejected by vomiting; violent vomiting may excite cough.

The blood is either clotted or fluid and dark; it may be mingled with remnants of food, and is acid at times in reaction.

HEMOPTYSIS

History of cough and other symptoms points to pulmonary or cardiac disease.

A feeling of weight and uneasiness in the chest, a saline taste, and a tickling in the throat precede the hemorrhage.

The blood is raised by coughing or clearing of the throat, though, if it be swallowed, vomiting may follow.

The blood is bright-red, frothy, in small coagula, sometimes mixed with mucus, and alkaline in reaction.

Prognosis.—Hematemesis, except it be due to rupture of an aneurysm, rarely presents a hopeless prognosis. In cases of splenic enlargement, hepatic cirrhosis, or gastric ulcer, it may prove fatal.

The treatment has been detailed in the discussion of Gastric Ulcer.

NEUROSES OF THE STOMACH

NERVOUS DYSPEPSIA

(*Neurasthenia Gastrica*)

Definition.—A functional disorder of the stomach, usually characterized by regularly (and sometimes irregularly) recurring attacks of gastric disturbance followed by almost complete freedom from symptoms. Sensory disturbances of the stomach are constantly present, and with these either motor or secretory disturbances or both may be associated.

Etiology.—The majority of cases occur in highly emotional and hysterical persons, under such exciting conditions as great anxiety, violent passion, dissipation, social excesses, mental overexertion in business life, grievances, and any startling news. The condition is most commonly met with in healthy-looking, ruddy-cheeked adults. It is more common in females. Persons living amid luxurious surroundings suffer most. Gastric neuroses may be of reflex origin, arising from derangement of the nervous system. Deaver states that they may be manifestations of disease in the liver, gall-bladder, bile-ducts, or appendix, which will demand surgical interference.

The symptoms follow immediately upon the action of the exciting cause and are largely under the influence of the emotions. In the ordinary form the gastric secretions are often normal, and the stomach is found empty after a test-meal within the physiologic time limit. There is anorexia, which occasionally alternates with a voracious appetite. After meals the patient complains of distress and oppression in the epigastrium; eructations, and an occasional regurgitation of the acid liquid or solid contents of the stomach, with heartburn, will also be noted. Vomiting is not rare, and occurs independently both of the time of eating and of the character of the food. *Gastric*

extricated from the old surroundings under the influence of which the case was started and has continued. Sea air has seemed to me to be more agreeable than mountain air in these cases, though I believe it to be an axiom of climatic therapeutics that the latter confers more lasting benefits than the former. These patients are often averse to taking exercise, but this sanitary measure should be insisted upon. Cold sponging of the surface, followed by friction to the skin, should be practised daily for its effect upon the nervous system. Occasional lavage, hot and cold douches, electricity (intra- and extra-gastric), and gastric massage may all be tried. In highly neurotic and hysterical females the S. Weir Mitchell treatment is often attended with good results. The hypochondriac form is often intractable. Strychnin, however, perseveringly used, and if coupled with a change of air, often proves beneficial. One of the most obstinate examples of this nature that I have seen occurred in a retired merchant living in Philadelphia. This man was finally cured in consequence of his own suggestion, resulting in his removal to the country and engaging in farming.

ESSENTIAL FORMS OF GASTRIC NEUROSES CHARACTERIZED BY MARKED AND PECULIAR ANOMALIES OF SENSATION, MOTILITY, AND SECRETION.

NEUROSES OF SECRETION

HYPERCHLORHYDRIA

(Hyperacidity)

Definition.—An augmentation of the secretory function of the stomach during the digestive period, resulting in excess of HCl.

Etiology.—Hyperacidity is common during digestion, and is usually due to the causative influences mentioned under Nervous Dyspepsia (grief, mental anxiety, mental overtaxation). The disease is common among the professional classes (male sex) and in the young. Highly seasoned foods and alcoholic intoxicants may occasion the condition. Lichty emphasizes organic disease of the gall-bladder and ducts as a cause, while chronic appendicitis or some other chronic inflammatory intra-abdominal lesion is a well-recognized cause.

Symptoms.—Hyperchlorhydria may be *continuous*, though more often *discontinuous* and lasts from a few hours to several days. After the periodic attack has lasted a long time it may gradually become a permanent condition. The patient first complains of *uneasiness* in the epigastrium one or two hours after meals. Later, this amounts to *pain*, and follows every meal after a like interval. The duration of the pain is from one to three hours. Acid eructations are frequently noted. The increase of hydrochloric acid interferes with the digestion of starches, and thus tends to increase the pain. On the other hand, however, a diet composed of albuminoids often affords relief, and the salts of the alkalies also ease the pain. Associated *nervous symptoms* (headache, irritability) are often observed, though the bodily nutrition is usually well maintained. *Palpation* of the epigastrium may show a diffused tenderness. Evidences of moderate gastrectasis may be detectable. The amylolytic power of the stomach is uninfluenced as a rule.

Diagnosis.—Though the diagnosis of hyperacidity is made probable by the above symptoms it is rendered certain only by a repeated analysis of the

gastric contents. The findings, according to Einhorn, are: (1) On examination of the stomach in the fasting condition the organ contains only a few cubic centimeters of juice; (2) one hour after Ewald's test-breakfast the hyperacidity is increased, owing to the great amount of free HCl present and there is an associated hypersecretion. To make a decisive diagnosis the examination should be made every ten minutes by means of the duodenal tube, as the height of the acidity may be reached before or long after the theoretic height of digestion.¹ Thus Rehfuss has shown that there may be three types of secretory curves normally, viz.: the isosecretory, the hypersecretory, and the hyposecretory, depending on the rapidity of acid secretion, height of acidity, and continuation of acid crest to the end of the limit of digestion.

Gastric ulcer must be eliminated. In this disease hyperacidity occurs, but the pain is aggravated immediately after eating, and is not relieved by albuminous food nor by large doses of alkalies, as in hyperchlorhydria of nervous genesis. In ulcer, moreover, the pain often leads to vomiting, and severe, painful attacks frequently occur at night.

Gastrosuccorrhea (Reichmann); Gastroxynsis (Rossbach).—In this affection there is an increase of hydrochloric acid, either constantly or intermittently, when no food is present. An *epigastric gnawing pain* and nausea appear in the full bloom of health. The *nausea* soon results in the *vomiting* of enormous quantities of gastric contents. The *appetite* is lost, but the thirst is excessive, and the amount of drink taken and of liquid vomited are proportional. During the night or in the early morning hours the patient commonly vomits large amounts of a clear or bile-tinted liquid containing hydrochloric acid and the gastric ferments in excess. This may be followed by persistent vomiting, attended with much retching. After a lapse of a few hours the ejection of a large quantity of highly acid liquid may be repeated. The *pain* often becomes intense, headache is common, and a tendency to collapse is usually marked. The attacks last, as a rule, about two or three days, when they quite abruptly give place to apparent good health. *Recurrence* at the end of periods ranging from a few months to a year or more are common. A physiologic form has been advanced.

The *diagnosis* is made upon the presence of the cause (a violent psychic shock), the clinical symptoms and course, as well as upon the results of oft-repeated analyses of the vomitus. Gastric ulcer and certain organic spinal and cerebral nervous affections, in which there is excessive gastric secretion, must be excluded before diagnosis can be made.

Gastrosuccorrhea Continua Chronica.—Reichmann first described a condition characterized by a *constant hypersecretion of gastric juice* either in the absence or presence of food. (Hawk and Rehfuss have shown that normally there may be present in the fasting stomach from 30–120 c.c. of gastric contents, usually containing bile and trypsin, regurgitated from the duodenum; the free and total acidity varying from 20 to 40 per cent. and 26 to 50 per cent. respectively). The *symptoms* are much the same as those in *hyperacidity*, but tend to become continuous, so that the vomiting finally becomes a daily occurrence. In the fasting state a highly acid secretion that contains no food-particles flows through the stomach-tube. Albuminoids are rapidly and starches slowly digested. The disease is quite rare, and must not be confounded with the organic diseases to which continuous gastric succorrhea may be secondary and upon which it is dependent. Schreiber, Boas, and others believe that this is almost always a symptom of gastric atony or gastric ulcer.

Larval Superacidity.—This variety arises early in the period of digestion; the amount of gastric contents after the test-meal is large, and consists mainly

¹ See papers of Hawk, Rehfuss, and their co-workers.

of a watery secretion with low specific gravity and with a normal acidity. Leube has described a neurosis with constant subacidity of the secretion.

Gastromyorrhea.—The fasting stomach often contains small quantities of mucus (5 c.c.), but when above 25 c.c. Cuttner considers it pathologic and terms the condition *gastromyorrhea*. It seems to be largely of nervous origin. There are two forms of the disease, the intermittent and the continuous. In the first, the attacks develop suddenly with severe headache, pain, and vomiting, and after a period varying from one to five days the attack suddenly ceases (Friedenwald). The other type is usually discovered in examination for chronic catarrh. The *treatment* is symptomatic, although lavage is of service in the acute form. The neurotic tendency must be combated during the intervals.

Achylia Gastrica (Einhorn).—The suspension of the gastric secretions may result either from gastric atrophy (common) or from a nervous derangement of secretion. The condition has been mistaken for carcinoma of the stomach. Lactic acid, however, is not present in excess. Eosinophil cells generally occur in the gastric juice. Skray found in cases of simple achylia that hydrochloric acid appeared in the stomach contents after meat was added to the test-breakfast, while in carcinoma it remained absent. Functional achylia of the stomach and pancreas may occur together (Orloff). Achylia gastrica may cause chronic lenteric diarrhea (A. A. Jones).

The **prognosis** in the foregoing affections is not bad as to life, and not infrequently a cure, even, can be effected.

Treatment.—The dietetic treatment differs according to different observers. Einhorn advises three large and two small meals, composed principally of nitrogenous articles, daily. Physiology, however, teaches that when milk, bread, fats, and starchy substances are taken, the amount of HCl secreted is small, hence the proper causal treatment is to limit the amount of proteins. Acids, tobacco, and spirits—substances that excite the glands of the stomach—must be excluded. The medicinal treatment should, in addition to meeting the general neurotic condition, consist of full doses of sodium bicarbonate or sodium citrate. In some cases more active alkalies than sodium bicarbonate may be needful—*e. g.*, magnesium and sodium salicylate, aluminum silicate (3ss–j ad aqua 3iij a. c.), either separately or in combination. Belladonna reduces acidity and may be combined with the alkalies. Lavage daily, before the chief meal, is beneficial and may be combined with a salt-free diet. Lemoine advises hydrotherapy and rest to strengthen the nervous system.

NEUROSES OF MOTILITY

INCREASED PERISTALSIS OF THE STOMACH

(a) **Belching and Eructations.**—These may be of *nervous origin* and are met with generally in *hysterical* subjects, and less frequently in *neurasthenics*. The air is swallowed, and then expelled with more or less noise, owing to an increased contractility of the stomach. The gas is *odorless*, and differs in this point from the gases of fermentative dyspepsia. Epigastric distress and distention often arise, and certain nervous phenomena, as anxiety or palpitation, may coexist. In hysterical subjects the belching may be from the esophagus alone.

(b) **Pyrosis** means regurgitation of the acid contents of the stomach.

(c) **Rumination (Merycism).**—A rare affection in which the food is regurgitated into the mouth, the cud chewed, and again swallowed after the fashion of ruminants.

(d) **Nervous Vomiting.**—This is a *reflex neurosis* that may affect persons of any age, though most frequently it is seen in adult females with an hysterical

tendency. Without previous nausea, and independently of the character of the food taken, the contents of the stomach are readily expelled or, more correctly speaking, regurgitated into the mouth, and then expectorated. Though this usually takes place after meals, it may occur without reference to meal-time—a feature that indicates its nervous origin. The *attacks* of vomiting are separated by longer or shorter intervals of excellent health. Periodic vomiting may also occur independently of hysteria or other nervous affections as pointed out by Leube. The *course* is rarely unfavorable.

(e) **Peristaltic Unrest** (Kussmaul).—It has been observed in compensatory hypertrophy of the stomach wall following pyloric stricture. In a case of gastric carcinoma in my own care the supermotility of the stomach caused an almost immediate expulsion of the gastric contents, and even of the rigid test-meal at certain times. True *gastrosplasm* shows no peristalsis and may be circumscribed.

(f) **Cardiosplasm**.—By this term is meant a painful cramp of the cardia. Two forms are distinguished: (a) acute cramp; (b) chronic cramp (exceedingly rare). Among causes are neurasthenia, hysteria, and local irritation (thermal, mechanical). Bassler found, postmortem, firm adhesions of the pleura, particularly at the base, in association. Chronic spasm may lead to complete atresia of the cardia, and is a distressing affection. In acute cardiosplasm the attacks may recur.

(g) **Pylorospasm**.—Cramp of the ring-musculature of the pylorus may be *primary* or *secondary*. The latter is due to intense local irritation (hypersecretion, gastric ulcer, excess of organic acids). The painful spasm in the pyloric region induces stagnation of the ingesta, followed by atony of the stomach and consequent dilatation. *Gastrosplasm* may simulate ulcer or ring carcinoma when confined to the pylorus.

Treatment.—To the regimenal management the attention of the physician should be primarily directed. The medicinal treatment is to be aimed at the causal nervous affection. The valerianates and the bromids often do good service. For the cramp of the cardia and pylorus belladonna is especially efficient; these failing, stretching of the cardia, either by means of a bougie or an inflatable bag, is indicated. If internal treatment fails in functional motor insufficiency, operative intervention may be indicated.

DIMINISHED PERISTALSIS OF THE STOMACH

(a) **Pyloric Relaxation or Incompetency**.—This is a neurosis that allows the partially digested gastric contents to pass the portals of the stomach prematurely. It likewise permits the regurgitation of the intestinal contents into the stomach. Its recognition is possible upon inflating the stomach, when gas may be seen to pass into the intestines, and also upon the regurgitation of intestinal contents into the stomach. It is frequently found when there is a hypo-acidity of the gastric contents.

(b) **Insufficiency of the Cardia**.—This condition leads to eructations and regurgitations, and when these are of aggravated form they impair the general nutrition. Ordinarily no ill-effects follow.

(c) **Atonic Dyspepsia**.—This may occur either as a neurosis or secondary to chronic gastritis and reflexly in chronic appendicitis, carcinoma, and tuberculosis of the intestines. It implies *hypomotility*. The *chyme* is retained in the stomach beyond the natural time-limit. There is an *epigastric oppression* with a distention of the organ during digestion that tends to become permanent. There are eructations of gas, an impaired appetite, and often constipation. The stomach is found empty in the morning, and six or seven hours after Leube's test-meal it contains some chyme.

Treatment.—The diet is to be regulated as in chronic gastritis with dilatation. It is rarely necessary to restrict the solids to any marked extent, but the quantity of fluids should be lessened. The patient must be taught to eat slowly and masticate thoroughly. His hygienic standard of living must be high, and he must not be allowed to overuse his mental faculties. Exercise in the open air and cold baths, properly regulated, are potent for good. Of medicines, strychnin stands first, and I have found the following formula of great service:

R. Tr. nuc. vomicæ, fʒiiss (10.0);
 Inf. gentian. q. s. ad fʒiv (120.0).—M.
 Sig. ʒij (8.0) three times daily.

Electricity is indicated, and intragastric faradization has given excellent results. The constipation is to be overcome by an appropriate dietary (green vegetables, graham bread, an abundance of fruit). There is an advantage in assuming the right lateral position, which hastens evacuation. Lavage deserves a prudent trial.

NEUROSES OF SENSATION

CARDIALGIA

(Gastralgia; Gastrodynia)

Definition.—Severe paroxysmal pain in the epigastrium in the absence of gastric lesions. There are two other forms of this disease that are clinically identical with nervous gastralgia, the one occurring in ulcer and carcinoma of the stomach, and the other in certain chronic nervous diseases, forming the so-called gastric crises.

Etiology.—The subjects are often hereditarily predisposed to neuroses of other types. Such conditions as anemia, exhaustion from repeated hemorrhages, and syphilis exert a *predisposing* influence. The female sex is more liable than the male, and in the former it appears to be dependent upon disturbances of the menstrual function or quite frequently upon hysteric conditions. It is sometimes excited by reflex irritation, by deep grief, worry, and great anxiety. Hypochondriasis and hyperacidity are also among its frequent causes.

Symptoms.—These are *sudden in their onset* as a rule, and quite characteristic. Occasionally the attack is preceded by anorexia, or it may begin with a sense of oppression and distention in the epigastrium, lasting for a few minutes. In any event, the onset of the attack proper is marked by *agonizing pains* in the epigastrium, that dart through to the back, and at times also pass around the lower ribs. The seizure lasts from a few minutes to an hour or two, and terminates with *eructations of gas*, or, less frequently, with vomiting. From the nature of the causative factors it is obvious that the gastralgic seizures are in nowise dependent upon the character of the food taken; hence the fact that they occur more frequently when the stomach is empty need occasion no surprise. Firm pressure over the epigastrium relieves the pain. *Nervous phenomena*, varying with the etiology of individual cases, are constant attendants, but cannot be detailed here. A distinct clinical variety is found associated with that form of nervous dyspepsia in which an excess of HCl is secreted (*vide* Hyperacidity); this occurs at varying intervals. Many functional nervous disturbances are thus subject to the law of periodicity. I believe that a very small percentage of cases are caused by malaria, since I have met with two such cases in a malarial district, both of which yielded readily to quinin.

The disease took on a desultory, periodic character, and was associated with other malarial symptoms.

Diagnosis.—The history, the absence of any local causes, the violent, spasmodic attacks of pain, that cease abruptly, and their occurrence at irregular intervals, will enable the clinician to render a positive diagnosis in most instances. The gastric crises that occur in locomotor ataxia closely resemble gastralgia and must be excluded. Gastralgia may be simulated by cholelithiasis (*q. v.*). To discriminate this condition from *gastric ulcer* is difficult, but stress has been laid upon the differential points in the description of the latter disease (*vide p. 778*).

Prognosis.—This depends entirely upon the causal condition. The disease itself has no intrinsic fatal tendency.

Treatment.—This is to be subdivided into: (a) the treatment of the attack; (b) the management of the intervals between the seizures. The pain is, as a rule, sufficiently intense to demand morphin, which is best administered hypodermically in combination with atropin. This should not, however, be given if an idiosyncrasy exist. In mild attacks the constant or the faradic current often affords prompt relief. Under these circumstances counterirritation, together with the internal use of Hoffman's anodyne or chloroform in small doses, may relieve the pain.

(b) *The Management of the Intervals.*—Here the physician's efforts should be directed to the detection of the causes and their removal by appropriate means. In hysteric females I have obtained good results from the prolonged use of valerianates, combining with them iron and arsenic, thus:

R. Ferri arsenatis,	gr. ij (0.13);
Zinci valeratis,	gr. xvij (1.20);
Quininæ valeratis,	gr. xxx (2.00).
M. et ft. cap. No. xvij.	
Sig. One after each meal.	

A change of air is often highly serviceable, and should be advised whenever financial considerations permit. These patients are constantly in a more or less exhausted, anemic, and run-down condition, and a tonic plan of treatment is always indicated to overcome the primary cause. In the intervals between the attacks digestion, as before stated, proceeds normally, and the stomach, therefore, requires no treatment. Constipation, if present, is a condition demanding relief not, however, by the use of purgatives, but by such means as massage, a suitable diet, enemata, or laxative suppositories. The physician must carefully regulate the sanitary particulars of the patient's daily life.

HYPERESTHESIA OF THE STOMACH

This is met with in functional and organic diseases, as well as in chronic gastric catarrh and other affections of the stomach. Again, it may occur as a *neurosis*, most frequently in chlorotic girls and women. There is an increased gastric sensibility, so that the mildest irritant produces *painful sensations* that may be either gnawing or burning in character. A feeling of fulness and nausea are among the common features of the complaint. Food and certain articles that are not easily digestible may afford relief, and, oppositely, fasting or restriction of diet may aggravate the condition. The complaint, however, is often aggravated during digestion, particularly after excessive indulgence in certain kinds of food (crabs, lobsters, oysters, strawberries). Cutaneous symptoms, as erythema and urticaria, may appear. *Hypochon-*

driasis, neurasthenia, and hysteria are often associated. The above symptoms are dependent upon an individual idiosyncrasy.

Treatment.—At first a restriction of the diet to soft and liquid articles should be tried, and later a cautious return to solid food is to be made. Of medicaments, the bromids, given for a period of two or three months, have given the best results in my own hands. For the chlorotic type iron in the form of Blaud's pill, in ascending doses, is the best treatment.

ANOREXIA

This consists merely in a loss of appetite, and occurs in many organic gastric disorders. It may also be a primary gastric *neurosis*, the latter being often associated with gastric hyperesthesia. Anorexia sometimes leads to a repugnance to food and a degree of abstinence that may induce grave nutritional disturbance. Among exciting causes mental shock of any sort ranks first. The recognition of anorexia as a neurosis of the stomach is difficult after the general nutrition has become seriously impaired. Chronic dyspepsia, phthisis, and other diseases associated with emaciation and debility must be excluded before the diagnosis is established.

HYPEROREXIA

(*Excessive Appetite*)

This may either be symptomatic of other affections (*e. g.*, diabetes mellitus); may be a gastric neurosis; or it may be the result of hypersecretion, as in gastric ulcer. It may also be paroxysmal (*bulimia*). The patient complains of burning sensations in the epigastric region and of an insatiable hunger. The symptoms of neurasthenia and hysteria are often in association. The local and general symptoms are relieved by food. It may also accompany affections of the brain, exophthalmos, and migraine. In *bulimia* the abnormal sensation of hunger may come on at any hour, even immediately after abundant food has been taken. When the morbid sensation of hunger develops more gradually and some time after meals it is spoken of as *polyphagia*.

Pica is the term applied to the craving for substances not used as food (slate-pencils, dirt, chalk).

Malacia represents the desire for highly spiced dishes (mustard, salads, pickles, fruits).

The above conditions are met with in neurasthenia, chronic gastric affections, and chlorosis.

VIII. DISEASES OF THE INTESTINES

METHODS OF DIAGNOSIS

Examination of the Feces.—Although the results are in some cases unsatisfactory, an examination of the feces should not be neglected, especially in the more serious affections of the intestine. This embraces: (a) a macroscopic; (b) a microscopic; (c) a chemical, and (d) a bacteriologic examination.

(a) The *macroscopic* appearances often suffice. A thorough inspection of the stools furnishes valuable points in regard to the presence or absence of coarse parasites, fragments of tumor, foreign bodies, concretions, blood, bile, fat, pus, mucus, undigested meat, and the like.

The shape, color, and consistence of the stools must be noted, and it is

to be remembered that in these particulars, as well as regards their frequency, they exhibit a considerable range of normal variations, according to individual peculiarities, the character of food taken, and so on. It is to be recollected that normal stools contain fat in varying amounts, for the reason that only a limited quantity can be emulsified and taken up from the intestine. The naked eye may, at times, detect its presence from the "peculiar silvery appearance" of the feces. Fat in the stools (*steatorrhea*) is often pathologic, and the separate affections in which it is met with will be considered hereafter. The dejections present a shining, tallowy appearance, either throughout or in circumscribed spots. Again, the fat may occur in the form of oil floating on the surface of liquid stools. Mucus is also visible, either as slimy or jelly-like masses, or as shreds and granules (sago-grains). Diarrheal stools should be examined macroscopically with great care for gross admixtures (flakes of casein, bits of meat, etc.). Constipational dejections often assume a rounded form (*sheep's dung*) on account of their delay in the large bowel. They may attain to the size of an orange, and may be, though rarely, enveloped in mucus or blood streaked. Their color is dark. On the other hand, the stools may be colorless in cases in which the bile-ducts are occluded; these usually contain a large proportion of fat, though not invariably. The effect of certain drugs upon the color of the stools is to be borne in mind. When blood is intimately mingled with the feces they have a reddish, dark- or blackish-brown (tarry) color, according to the quantity and the time allowed for decomposition in the intestine. Blood, either clotted or fluid, may also be passed in a pure state. Its source is usually the lower bowel, though when peristalsis is augmented, it may come from the small intestine, as in typhoid fever. Pus may occasionally be recognized macroscopically. From a diagnostic point of view it is most important to examine for biliary concretions in doubtful abdominal colic. "For the detection of small concretions the stools should be passed through a sieve" (Ewald).

(b) *Microscopic Examination*.—Diarrheal stools can be examined as discharged, but to solid and mushy dejections normal salt solution or distilled water should be added and all hard masses thoroughly broken up. Different portions of the stools are to be selected for microscopic examination. *Microscopically* we are enabled to detect the eggs of parasites, pus, blood, protozoa, mucus in the form of shining, vitreous, homogeneous, or whitish masses; and in the interior of the latter certain pathogenic bacteria, various crystals, and intestinal epithelium may be seen. Remnants of vegetable food may simulate mucous islets, but the former strike a blue color on the application of Lugol's solution. Microscopically, diarrheal stools show undigested muscle-fibers, fat-crystals, vegetable cells, starchy granules, and innumerable bacteria. Von Leersum¹ advocates the sedimentation process until the sediment finally contains most of the meat-fiber, and that the nuclei be then stained and examined to estimate the degree of pancreatic digestion. Undissolved starch in even moderate quantity points to catarrhal enteritis of the small intestine. On microscopic examination of the dejections in constipation we find "a copious detritus of brown or black color, usually numerous colorless or slightly tinged triple phosphates (phosphate of ammonium and magnesium crystallizing in the form of a coffin-lid), or, more sparse, crystals of neutral phosphate of lime." Seldom do we meet with the rhomboid plates of cholesterin, which are recognized in that they are colored from a reddish-brown to violet by dilute sulphuric acid (1 : 5), and become blue or green on the further addition of a solution of iodine. Needle-shaped crystals of fat, single and also in the forms of tufts, are frequently met in obstruction of the biliary ducts. Bile-pigment

¹ *Munch. med. Woch.*, February 6, 1912.

cannot be detected. Remnants of food are sparsely present in normal feces. Epithelium from the mucous membrane, pus-cells, and blood-corpuscles, unless they come from the passage of the fecal mass through the anus (in which case they are simply adherent to the external surface of the scybala and are but little changed), are greatly altered; they are fatty, degenerated, shrunken, and hardly recognizable. Rhomboid crystals of hematin may be at times observed. The microscopic examination for animal parasites will be referred to in appropriate sections of this work.

(c) *Chemical Examination*.—The presence of bile-pigment is easily detected by the Gmelin reaction. The stools must, if needful, be rendered fluid by the addition of water, then filtered, and the filtrate allowed to dry. At the margin of the drop the characteristic green color will appear. Urobilin strikes a red color. The stools in diarrhea may contain ferments capable of digesting albuminoids. The fatty acids are distinguished from fatty soaps by the solubility of the former in ether.

For the detection of occult blood, to an ethereal extract of 2 to 5 c.c. of liquid feces or solid stool reduced by water, 2 c.c. of a 10 per cent. solution of guaiac in glacial acetic acid is added, followed by 2 c.c. of hydrogen dioxid, the mixture is thoroughly shaken, and in the presence of blood turns blue. A dilution of blood, 1 in 250,000, is recognized by the Adler technic, in which to boiled feces add 1 c.c. glacial acetic acid in which a small amount of benzidin has been dissolved, alcohol, and an equal volume of hydrogen dioxid; if positive, a dirty green or deep blue develops. Boas' phenolphthalein test may also be employed.¹ In bleeding from the stomach and intestines, from the mouth, pharynx, rectum, or vagina, the ingestion of meat, watermelon, or medicinal iron must always be excluded. The indol-reaction may be increased, pointing to increased intestinal putrefaction.

(d) A *bacterial examination* of the intestinal contents, and particularly of any mucus or mucopus that may be discharged, may decide the diagnosis of certain intestinal disorders (tuberculosis, amebic dysentery). For the method of carrying on these investigations the reader is referred to special works on diagnosis and bacteriology.

(e) The roentgen rays have been shown to be of great diagnostic value in many intestinal conditions.

Physical or External Examination.—*Inspection*.—This should be made with the patient in the dorsal position and with proper illumination. Localized prominences are to be noted (sometimes simulated by localized contractions of the abdominal muscles). The influence of respiration on these circumscribed bulgings is also to be observed. In the absence of unusual distention of the abdominal walls it is of great value to inflate the large intestine with air *per rectum*, and to note the progressive distention of the intestinal coils as a means of detecting obstructing lesions in the bowel; the position and mobility of a tumor should also be noted. It is often of marked aid to inspect the mucosa of the rectum by the use of approved specula. The volume of the abdomen may be diminished or even "scaphoid." Abnormal peristalsis may rarely be noted (important if associated with distention).

Palpation.—This is of first importance. The patient should occupy the dorsal decubitus, with the head raised, the thighs drawn up, and the mouth open, so as to relax the abdominal muscles. Something may be gained in this direction by distracting the patient's attention. I have found that placing the patient in the lateral decubitus, with the thighs flexed on the abdomen, to be the most satisfactory way of determining the degree of mobility of certain tumors. The examiner should not fail to remember the knee-elbow position

¹ *Amer. Jour. Gastro-enterology*, September, 1911, p. 48.

in cases in which it is desired to palpate the parts occupying the bottom of the pelvic cavity and all deep-seated, movable growths. In certain cases relaxation of the abdominal muscles is only obtainable by anesthetizing the patient, and I do not hesitate to do this in cases in which the diagnosis is important. In palpating the abdomen for abnormal conditions we must keep in mind steadily the relations of the different parts of the intestines, and also that the latter may vary considerably in position—a fact particularly true of the transverse colon (*vide* Enteroptosis). In this connection Ewald's statement "that abnormally situated organs or neoplasms of parts other than the intestines will, under the pressure of the intestines filled with air or water, return to the position that the organ normally occupies," should be emphasized. New growths of the pancreas, of the spinal column, or of the pelvis, and retroperitoneal tumors will remain fixed. Palpation may detect pathologic peristalsis, and increased resistance if the coats are thickened. Tenderness, localized or diffuse, as well as peritoneal friction, is noted. The rectum may be palpated if the symptoms point to disease of that organ.

The palpation of pathologic conditions of the intestines will be considered in connection with the separate intestinal affections.

Percussion detects a fluid effusion either in the general peritoneal cavity, the position varying with the patient's posture, or in circumscribed localities; the latter must not be confounded with areas of dulness that are occasioned by splenic and hepatic enlargements, solid new growths, or abscesses. Air in the peritoneal cavity (*meteorismus peritonei*) generally gives a pure tympanitic note, though if the tension be very strong, a non-tympanitic tone may be elicited. These sounds are general, even extending up to the fifth or fourth rib, and hence they cover the regions of the spleen and liver. The best results when the abdomen is not tense are obtained after inflation of the large intestine with air. The pitch of the tympanitic note becomes elevated with increase in the tension of the gut; it falls with relaxation of the bowel. Hence the large cannot always be told from the small intestine by percussion.

Auscultation.—Noises are often audible either at a distance or by means of a stethoscope applied to the abdomen. They are sometimes occasioned by the natural peristaltic movements or by certain voluntary or involuntary spasms of the abdominal muscle. I have repeatedly confirmed the observation of Ewald, who frequently found in those suffering with chronic intestinal indigestion a swashing or splashing noise, sounding as though air and water were being forced through a narrow space in the ileocecal region. These sounds may rarely be found in healthy persons. Similar noises sometimes have their seat in the descending colon, particularly if the bowel is unnaturally dilated by air or fluid. They are often audible prior to an evacuation in cases of colitis. Noises may also originate in the transverse colon, and to discriminate these it is necessary to empty the stomach if we would avoid confusion with identical gastric sounds. Direct auscultation of the intestines renders audible the peristaltic movements, and the absence of the latter indicates paralysis of the intestine, which may be local or general. Friction-sounds may be audible when inflammatory exudates are present. When obstruction of the large intestine is suspected, auscultation should be practised while air is being forced into the rectum, inasmuch as the degree of permeability can be thus determined. Metallic tinkling and amphoric noises may be audible, particularly on making auscultatory percussion, but these are without real diagnostic value.

and strength, should be carried out. A condition of subnutrition and deficiency of body weight is often operative as a cause, and such patients should be restored to normal tone and weight by suitable measures. Following acute disease patients should not be permitted to resume active occupation until health is fully regained, especially if any tendency to gastropotosis is shown. An abdominal binder is useful after delivery, and after tapplings for recurring ascites.

Success in the treatment lies in the direction of meeting the special etiology of individual cases. Unfortunately, in many cases, splachnoptosis is caused mainly by a congenital weakness of the supporting ligaments, to which certain of the other causative factors may be superadded. The medical treatment aims at meeting symptomatic indications, such as flatulence and fermentation, as well as overcoming atonicity of the gastro-intestinal tract. Regular bowel movements are to be secured by the use of mineral oils; dose, f3j on retiring, to be renewed on the following morning if required. To improve the tonicity of the abdominal walls, massage, gymnastics, and athletic exercises, as well as hydrotherapy, are useful.

A careful dietary is to be advised in cases in which the digestion is more or less impaired. Tender meats, milk, stale bread, green vegetables, and stewed fruits, as well as small amounts of carbohydrates and fats, may be allowed. It is often necessary to increase the body weight; this may be accomplished by adding raw eggs and milk between meals, associated with rest. The Weir Mitchell rest treatment is indicated in cases manifesting marked neurasthenic symptoms, combined with emaciation. Iron and arsenic are the remedies of choice if anemia be present.

Many cases are relieved by the support of a properly adjusted belt and pad. McCloskey advises for the support of the viscera a strip of zinc oxid adhesive plaster across the lower abdomen, to each end of which is attached a bandage long enough to reach around the body above the iliac crest.¹ My own preference is for a belt which should not extend higher than the umbilicus above, and it should be adjusted while in the recumbent posture, the patient being taught to draw the abdominal viscera upward at each step during its application, so as to furnish a support to the fallen organ. The aim should be to keep the belt fitting quite snugly below but loosely above, and, to prevent its riding up, perineal straps should be provided. A thin pad should be placed across the lower segment of the belt. The great majority of the cases can be successfully treated in this manner, although both time and patience are required. Operations for the relief of ptosis have been extensively advocated and have run in great waves of popularity, which have so ebbed in the present time that only for extreme, marked symptom-producing ptoses are operations performed. Numberless kidneys have been sewn into position, stomachs stitched up, colons removed, but without sufficiently good results to warrant a continuation of the practice.

INTESTINAL CATARRH

(*Catarrhal Enteritis; Muco-enteritis*)

Definition.—A catarrhal inflammation of the mucous membrane of the whole or of any anatomic division of the intestinal tract. It may be either acute or chronic, primary or secondary. The chronic variety occurs less frequently than its counterpart, chronic gastritis, particularly in adult life.

Pathology.—The morbid lesions of the acute variety do not differ essen-

¹ For details, see *Jour. Amer. Med. Assoc.*, October 28, 1911.

tially from those met with in catarrhal inflammation of any other mucous membrane. The first stage is characterized by swelling and dryness of the mucosa; this is soon followed by a copious exudation of mucus, and more rarely of pus, which bathes the membrane more or less completely. After an abundant secretion is poured out the membrane appears rather pale, though the tips of the valvulæ conniventes in the small intestine may appear reddened. The solitary and agminated glands, as well as Peyer's patches, may stand out prominently, owing to their corrugated condition (*follicular enteritis*). The apices of the solitary glands often undergo a necrotic change, thus forming follicular ulcers. The remainder of the mucosa may also be the seat of rather extensive areas of superficial erosion, though this must not be confounded with postmortem softening of the epithelium. In some cases the desquamation of epithelium is more pronounced than the abnormal mucous secretion. In *chronic* intestinal catarrh the mucosa presents a slaty hue, with a more or less dark pigmentation of the villi and follicles; it is in most instances thickened, owing to an increase in its connective-tissue elements. In a smaller number of cases it is thinned, particularly in the intestinal catarrh of children, on account of atrophic changes affecting chiefly the glandular and muscular layers. Roughening of the inner surface of the bowel, due to projecting glands, is frequent in those forms of chronic intestinal catarrh that are attended with thickening of the coats. Polypoid cysts may develop in long-standing cases.

Etiology.—The **primary** form is produced by (a) local irritants, either mechanical or toxemic, that find their way into the intestinal canal. The chief source of these excitants is an unsuitable dietary, and especially is this the case in children. It is readily seen from this fact why the stomach and the intestines are often simultaneously involved in a catarrhal process. (b) Overeating may be productive of the disease, though this often excites diarrhea by merely increasing intestinal peristalsis. (c) Idiosyncrasy has a positive influence, the ingestion of certain substances not difficult of digestion being invariably followed by this affection in individuals thus predisposed. (d) Toxic substances, whether in the form of tainted food-stuffs (spoiled meats, ice cream, beer) or inorganic poisons (mineral acids, caustic alkalies, mercury, arsenic) or irritating cathartics, often produce intestinal catarrh. (e) Impure water, or water to which individuals are unaccustomed. (f) Atmospheric changes, particularly a prolonged high or a sudden fall of temperature, the latter being especially apt to cause it in children. (g) An excess or a lack of biliary secretion. Two functions of the bile (its antiseptic properties and its power to stimulate peristalsis) must not be forgotten: the one explains how a paucity of this secretion favors the abnormal processes of fermentation that are capable of exciting catarrh, and the other makes plain the possibility of a bilious diarrhea being due to an excessive hepatic secretion. It is not clear, however, that the latter condition is attended with an actual catarrhal process. The same is true of diarrhea due to fright, excitement, or other nervous influence. (h) Bacteria are, doubtless, among the *excitants*—*e. g.*, the normal colon bacillus, under conditions favorable to its growth and development. The small intestinal *diplococci* probably operate to produce catarrh, particularly fermentative dyspepsia (Schmidt and Strasburger).

Secondary or complicating forms are caused: (a) By direct extension from adjacent organs (ulcers, gastritis, peritonitis, hernia, and invagination); (b) by general infectious processes (septicemia, pyemia, typhoid fever, dysentery, cholera, tuberculosis, pneumonia).

The **chronic forms** are met with (a) in certain cachectic states (carcinoma, chronic malaria, chronic Bright's disease, Addison's disease, and profound anemia); (b) in connection with disturbances of the circulation, particularly

often disturb the general health considerably. The patient is languid, and prostration is prominent; he suffers much from headache, and pyrexia is common, the temperature often reaching 100° to 103° F. (37.7°–39.4° C.). The higher temperatures are seen among children. Additional evidences of a systemic infection are sometimes observed, such as painful enlargements of certain joints, severe muscular pains, and albuminuria.

Complications.—The symptoms of gastric catarrh (vomiting, nausea, and pain immediately after feeding) are often associated with those of enteric catarrh; the combination is then spoken of as *gastro-enteritis*. Acute nephritis has been noted as a sequel.

Special Forms.—Though the anatomic limits in the more or less local forms of intestinal catarrh cannot be made out definitely, yet the different clinical pictures observed often enable us to fix the location of the disease with considerable accuracy; it is important, moreover, from the standpoint of the treatment, to accomplish this whenever possible. The following may be briefly described.

(a) *Duodenal catarrh (duodenitis)*, in which form constipation, often obstinate, is present in the place of diarrhea, the colon not being affected; merely local pain, tenderness on palpation, and uneasiness are complained of. These symptoms may frequently be overshadowed by those referable to the stomach when gastric catarrh coexists (*gastroduodenitis*). Without *jaundice* (usually present) due to the occlusion of the common bile-duct in consequence of the swelling of the duodenal mucous membrane, we cannot render a positive diagnosis.

(b) *Localized catarrh of the jejunum and ileum* cannot always be distinguished. The condition is often found to be a more or less prominent feature in general enteric catarrh, in which complaint diarrhea is a prominent symptom. The existence of this special variety may be safely inferred when certain enteric symptoms are combined with marked gastric disturbance. Under these circumstances the symptoms indicative of inflammation of the small intestines are rumbling noises (*borborygmi*), colicky pain, swelling, and slight tenderness over the abdomen in the vicinity of the umbilicus or over other regions occupied by the small intestine. Finally, an *examination of the stools* furnishes valuable points for differential diagnosis. It must be kept in remembrance that in catarrh of the small intestine the stools may be quite solid, despite the increased peristalsis caused by the catarrhal process (*vide ante*). More frequently, when the ileum is the seat of catarrh the colon is also implicated, this combination being attended with diarrhea, even if it be of minor severity. The thin stools "contain food remnants that point indubitably to implication of the small intestine." As the result of increased peristalsis of the small intestine its contents are passed into the large bowel with undue rapidity; hence the latter contains undigested food constituents and other substances that are normally found in the small intestine. These pass from the rectum unchanged. They are mainly starch, fat, and masses of meat-fiber, the latter of which may be of sufficient size to be seen by the naked eye. This would be pathognomonic evidence of the form of catarrh in question if it were not true that increased peristalsis of the small intestine, due to other conditions, as anemia, extreme nervousness, and fever conditions, that are not seen in ileojejunal catarrh, causes the same fecal peculiarities. An acid reaction of the dejecta points to catarrh of the small intestine. *Microscopically* the stools show hyaline particles of mucus, giving rise to a speckled appearance.

In health the contents of the small intestine give the characteristic color reaction for bile-pigment, while the contents of the large bowel and the stools do not. There is quite often a large admixture of undecomposed bile-pigment

(Strümpell) that responds to Gmelin's test,¹ a fact of considerable value in diagnosis. Nothnagel has called forcible attention to the fact that *bile-stained* stools and small *pigmented* masses of mucus are met with, and are highly characteristic of the diarrhea that marks catarrh of the small intestine.

(c) *Colitis*.—The joint appearance of abdominal pain and diarrhea is almost pathognomonic of this condition. These symptoms, in the absence of the more prominent and above-mentioned clinical features that have special reference to inflammation of the small intestine, point to the fact that the large intestine is the chief seat of the disease.

Physical examination is only partially confirmatory of the rational symptoms. The chief sign is tenderness on palpation over the track of the colon. An *ocular examination of the stools* furnishes important practical results. They may contain blood and mucus, and the latter often in masses large enough to be readily visible to the naked eye; it is not intimately mixed with the feces, as in catarrh of the small intestines, but forms separate masses. The feces are often of the consistence of soup. "If the catarrh affects the lower portion of the large intestine chiefly, it may be that the intestinal contents are already formed" in firm lumps, which may sometimes be wholly or partly enclosed in a layer of mucus (Strümpell).

Such *general symptoms* as loss of flesh, weakness, and sallowness of the skin are often observed. Simple diarrhea, lasting but a few days, as a rule, is to be classed with catarrh of the large intestine, since these affections imply increased peristalsis of the large bowel. It is not always easy, however, to discriminate diarrhea due either to purely functional influences or to catarrh of the rest of the intestinal tract.

(d) *Proctitis*, or inflammation of the rectum, is characterized by painful tenesmus and by the presence of large quantities of mucus and pus, particularly in the dejections. The disease may be primary, though more often it is secondary to morbid lesions either in organs that are adjacent to or in the rectum itself.

Chronic intestinal catarrh may, comparatively rarely, be a *primary disease*, developing gradually. It may also be *secondary* (*vide* Pathology) at times to one or more attacks of acute intestinal catarrh. Generally there are no other local symptoms to call attention to the condition than *chronic diarrhea*. More rarely there are, in addition, colicky pain and tenderness over the abdomen. The diarrhea often alternates with constipation, and this is most apt to be the case when the disease is of idiopathic origin and affects only the large intestine (Nothnagel). *Constipation* is constant in those cases in which *atrophic alterations* occur in the glandular and muscular coats, as well as in those in which the lesions are in the small intestine. When constipation is not present the stools are thin, pale, sometimes fermented, emitting offensive odors, and vary greatly in number and quantity. There is commonly present *viscous* mucus. When the small bowel is also implicated food-remnants are *found* in the dejections (*lienteric diarrhea*). *Microscopically*, the picture does not differ from that of the acute form. That form of diarrhea occurring in *organic diseases of the heart, liver, and lungs* demands brief special mention. Here serum of the blood is made to exude into the intestines, owing to mechanical obstruction to the return of the venous blood, and this results in a liquefaction of the feces. The stools are apt to be most copious and numerous during morning hours. Sometimes an irresistible desire to evacuate the bowels seizes the patient as soon as his feet strike the floor on rising in the morning; two or more serous discharges follow each other at short intervals. Stools

¹ This consists in bringing a few drops of nitric acid in contact with the intestinal contents, when the characteristic play of colors appears. (See also Methods of Diagnosis p. 852.)

quently, all discharges cease until the following morning, when the same symptoms are repeated. The *general nutrition* suffers visibly in chronic enteritis, and emaciation eventually becomes pronounced. I have also noticed slight pyrexia in the evening hours.

Differential Diagnosis.—Among the diseases likely to be confounded with acute catarrh of the intestines are *typhoid fever*, *dysentery* (diseases in which diarrhea is a cardinal symptom), *peritonitis*, and *colic*. The chief differential features between simple colic and enteric catarrh may be contrasted thus:

ENTERIC CATARRH	COLIC
Diarrhea is generally present.	Constipation is present.
Fever may be slight or marked.	No fever.
Pain is griping, and followed by diarrheal stools.	Pain is colicky, more severe, and is not followed by diarrheal discharges.
Tenderness in the intervals between pains.	No sensitiveness on palpation.

From *peritonitis* we may readily distinguish catarrh of the intestines by the more intense pain and tenderness, by the constipation, the greater tympany, the constitutional disturbance, the anxious face, thoracic respiration, and immobility of the patient, all of which characterize the former disease. The characteristic symptoms of *typhoid fever* (the typical temperature-curve, swelling of the spleen, eruption, Widal test) and of *dysentery* (scanty, frequent stools, tenesmus) are easily separable from enteric catarrh. In children, however, the diagnosis between typhoid fever and simple catarrh of the bowels offers considerable difficulty; but the temperature record, the enlargement of the spleen, the characteristic eruption, and the Widal reaction, taken unitedly, will warrant the diagnosis of typhoid fever and exclude acute enteritis.

In diagnosing chronic intestinal catarrh we may have difficulty in eliminating *lardaceous disease of the bowels* and *ulcerations*. The latter condition will be excluded hereafter. Boas recommends lavage in the diagnosis (about 1 liter of lukewarm water through a rectal tube); the funnel is then lowered and the dejecta siphoned off. If the recovered fluid contain mucus, catarrh is present. *Amyloid degeneration* is a general disease, affecting primarily other organs than the bowel, and hence lardaceous diarrhea is always preceded by the clinical indications of disease (enlarged viscera, albuminuria) elsewhere. The condition also gives a definite *etiology* as a rule.

The **prognosis** in uncomplicated cases is favorable, though the possibility of merging into the chronic form must be borne in mind. Occurring in weakly subjects and in the course of debilitating affections, *acute catarrh* of the intestines may endanger life. Its duration varies much—from three to ten days or more—according as the type of the individual case is mild or severe.

The prognosis in the *chronic forms* is moderately good as to life, though as cure it is not so, the disease often enduring for many years together, or as long as the chronic conditions producing it remain unremoved. It sometimes exhausts the systems of those suffering from serious causal affections of a chronic nature, and occasionally it ultimately proves fatal. The prognosis will depend largely upon the character of the etiologic affection, but intestinal catarrh invariably renders the prospects of life more gloomy.

Treatment.—Respecting the treatment of this affection the views of the profession have undergone many changes, even within recent years; hence it may be reasonably inferred that our present therapeutic methods are by no means satisfactory.

Hygienic and Dietetic Management.—In the not uncommon mild cases, due to errors in diet, a mild purgative, followed by proper *dietetic treatment*, is all that is required. Albuminous food in liquid form, such as skimmed milk,

weak broths, and even semi-animal articles of diet, as eggs, oysters, sweet milk with seltzer, are usually well borne. In the severe forms predigest-liquid food only should be allowed. When the chief seat of the disease is the large intestine we may allow easily digested starches and certain green vegetables (arrow-root, sago, lettuce, water-cress); the coarser vegetables, all fats, and most fruits should be withdrawn absolutely. Lassablière obtained brilliant results from the use of 1 part of condensed milk in 4 parts of rice-water, allowing from 1 to 2 quarts of this milk-rice-water per day. Rest in bed is especially beneficial in that it serves to keep the abdomen warm and mitigates the pain and diarrhea, and, in short, cures the disease. Sinapism should be applied at the outset until the skin is reddened, succeeded by light linseed poultices until the local sensitiveness has, in a great measure, subsided; after this a flannel band may be applied. The local abstraction of blood by a few leeches, applied to the abdomen or anus, is beneficial in the early stages in severe types of enteric catarrh, provided the patient's strength is good.

Medicinal Treatment.—It is sound practice to prescribe a mild cathartic (castor oil, calomel, or rhubarb, followed by a saline) with a view to getting rid of decomposable intestinal contents. Combined gastric lavage and high intestinal irrigation has recently yielded excellent results in my hands; it is an appropriate method of overcoming the fermentative processes that tend to excite and maintain the condition.

If the chief tenderness be localized in the right iliac fossa, corresponding to the course of the colon, a simple enema, slowly given, will stimulate the bowel sufficiently and cleanse it more effectually than a cathartic. Subsequently, chief reliance is to be placed on intestinal antiseptics and astringents, though it must be recollected that the selection of internal remedies must, in part, be influenced by the etiologic indications. For instance, if the cause has been exposure to cold or wet, besides the efforts directed at the local condition diaphoretics and febrifuge mixtures are serviceable. I have found the following combination to be of benefit in controlling the local inflammatory action:

R. Phenylis salicylatis,	3ss (2.0);
Bismuthi salicylatis,	3j (4.0);
Creosoti,	℥x (0.6).
M. et ft. cap. No. xx.	
Sig. One every three hours.	

If pain be troublesome, opium or acetphenetidi may be combined with the above formula.

In many instances the secretions of the intestinal tube are decreased for a considerable period after the most active symptoms have been subdued. Here we must supplement the natural juices of the bowel; this may be satisfactorily accomplished by the following agents in a salol-coated capsule:

R. Pancreatini,	3j (4.0);
Sodii bicarb.,	3ij (8.0).
Ft. cap. No. xii.	
Sig. One an hour after meals.	

In cases in which the large intestine is chiefly affected, and when the condition does not yield to internal medicines, treatment by medicated colonic irrigations is useful. When there is reason to suspect that the main lesion is in the large bowel, small enemas of starch-water (3ij—60.0), with laudanum (℥xx to xxx—1.33—2.0), every four to six hours, are also efficacious. If

colicky pain be severe, morphin (gr. $\frac{1}{8}$ —0.008) should be given hypodermically in addition to the measures before suggested. If the diarrhea shows no tendency to abate after forty-eight hours of the general treatment above outlined, large doses of bismuth (gr. xxx to lx—2.0—4.0) every three or four hours should be tried. In my own hands lead acetate (gr. ij—0.3), with the extract of opium (gr. $\frac{1}{8}$ —0.008) in pill form, has proved a most efficient combination. The thirst is best relieved by chipped ice in small quantities or by carbonic acid and Apollinaris waters. For distressing flatulence we may prescribe the alkaline carbonates, or spirits of ammonia, and some carminative. The oil of cajuput is a most valuable drug in the treatment of excessive fermentation (Murrell).

In *chronic catarrh* of the intestines the local treatment is of paramount importance. Daily irrigation of the bowel with a weak solution of some antiseptic agent, as salicylic acid (gr. v to \mathfrak{z} j—0.3—30.0), boric acid (gr. x to \mathfrak{z} j—0.6—30.0), creolin (m̄v to \mathfrak{z} j—0.3—30.0), or with some such astringent as tannin (gr. v to \mathfrak{z} j—0.3—30.0), or finally with an alterative, such as silver nitrate (gr. $\frac{1}{4}$ to \mathfrak{z} j—0.016—30.0), will be found to be serviceable. The latter solution is a most excellent remedy, but sometimes excites pain if too concentrated. I often use a mild antiseptic or astringent with the foregoing, giving each on alternate days, and thus obtain happy results. The only appliance needful is a fountain syringe with a soft-rubber end-piece, which should be gently introduced for a considerable distance into the bowel. The fluid used should be warmed to 90° F. (32.2° C.), and the quantity administered at each sitting should be not less than 2 to 3 pints (1–1.5 liters); this should be allowed to flow into the bowel slowly. The patient should, as a rule, assume the dorsal decubitus, though if the fluid is to be carried as high up as possible, the knee-elbow position may be assumed or the patient may be placed on the left side with the hips elevated. Again, turning him from side to side during the irrigating process may be warmly recommended.

The same careful attention must be paid to *hygienic details*, and especially to the diet, as is directed in the acute form. In addition, flannel should be worn next the skin both in winter and summer. If the strength will admit of it, cold baths are useful.

A stay at a suitable spa (Saratoga, Bedford, Virginia Springs, Carlsbad, Kissingen) often produces most satisfactory results.

Among internal agents, zinc oxid (gr. v to x—0.3—0.6—t. i. d.), silver nitrate, lead acetate, and alum, given with tonics, such as strychnin, arsenic, and iron, are especially to be recommended.

The management of this troublesome malady depends upon the indications furnished by the causative affections. No method of treatment, however, can succeed that is not carried out patiently, systematically, and over long periods of time.

DIARRHEAS OF CHILDREN

ACUTE GASTRO-INTESTINAL CATARRH

(*Acute Gastro-enteric Infection; Summer Diarrhea; Gastro-enteritis; Cholera Infantum; Mycotic Diarrhea*)

Definition.—This is the usual intestinal trouble that prevails during the warm summer months. It usually takes the form of an epidemic, and its course is manifested by a sudden onset, high fever, irritability of the stomach, frequent watery evacuations, and symptoms of nerve involvement. This form of diarrhea usually follows an attack of acute indigestion, in which it very

frequently has its origin (*acute dyspeptic diarrhea*), Acute gastro-intestinal catarrh (*cholera infantum*) stands midway between acute indigestion and ileocolitis.

Etiology.—Two important conditions seem to be necessary to influence the disease—*temperature* and *diet*. A general and well-recognized belief associates special danger with the second summer of children. Out of nearly 2000 fatal cases collected by Holt, only 3 per cent. were exclusively breast fed. Generally speaking, the disease has its origin in some irregularities in artificial feeding. Heat and season are important elements in the continuation of the disorder when once commenced.

It is seen from May to September, the greatest prevalence occurring in July. The pauper element of large cities furnishes most instances.

Flexner and Holt assert that the *Bacillus dysenteriae* may be isolated from the intestinal discharges, and from the intestinal mucosæ in a large percentage of cases developing along the Atlantic coast of the United States, during the summer months. Holt found *Bacillus dysenteriae* in 50 per cent. of cases at the Babies' Hospital of New York. The Flexner-Harris type of bacillus is most often encountered, while the "Shiga" type is but occasionally recovered. It is common for cultures to develop streptococci in connection with the *Bacillus dysenteriae*, and both organisms appear to grow luxuriantly together, which renders it impracticable to decide whether the lesions of the intestines and the general symptoms depend upon one or both of these organisms.

Booker, Jeffris, Baginsky, and Metchnikoff affirm that the proteus class of bacteria are commonly present, and that they are pathogenic. The *Bacillus dysenteriae* reacts with the serum of infected children.

Pathology.—A catarrhal swelling of the mucosa of the large and small bowel is present; the mucosa itself is pink in color from capillary congestion. Peyer's patches are enlarged. The whole intestinal tube shows an early stage of inflammation (ileocolitis). In addition, there is most likely some involvement of the sympathetic nerves, leading to dilatation of the capillaries and transudation of serum into the intestine, and to alterations of the pulse, temperature, and respiration. Its nature is paralytic, and closely resembles in its results experimental sections of the sympathetic nerves. The changes in the other organs are slight. Bronchopneumonia frequently occurs. The spleen is often swollen, the brain is anemic, and the kidneys are congested.

Symptoms.—Clinically, there are three forms of acute enteric infection: (1) Acute dyspeptic diarrhea; (2) cholera infantum, and (3) ileocolitis.

(1) *Acute Dyspeptic Diarrhea.*—There may be merely an increase in the number of stools, with or without fever; restlessness is usual at night. This condition may continue for two or three days, when the stools become more frequent and offensive, containing undigested food and curds. The odor by this time is very pronounced. Frequently the disease has a sudden onset, with vomiting, griping pains, and fever, which may quickly rise to 104°, 105°, or 106° F. (40°–41.1° C.). *Convulsions* may be the commencement of the attack. The abdomen is sensitive and swollen, and the child lies with its legs flexed on the stomach. The stools consist of grayish or greenish-yellow feces (mixed with curds, portions of undigested food) and some fluid. In children two years of age and older the stools may contain unripe fruit or large curds from excessive drinking of milk. Relapses are frequent, and during hot weather the frequency of the attacks may lead to a persistent enterocolitis.

In delicate children a severe attack, especially if it is accompanied by convulsions, may prove fatal.

(2) *Cholera Infantum.*—The initial symptoms are sudden. The child

voids immense stools, at first fecal, if no preceding diarrhea have been present. Soon they become watery, light yellow or greenish in color; frequently they are so thin and colorless as to pass through the napkin without leaving a stain. At times they contain a few yellow or greenish flocculi or a mass of mucus, and in all cases they are odorless. Very often the stools are brown and liquid, with a small quantity of fecal matter, having a peculiar musty odor that clings to the napkin and child for days. The number of stools per diem may vary from six to thirty, and a most remarkable feature is the fact that they are evacuated with considerable force.

The *stomach* becomes irritable, refusing everything; even ice is rejected as soon as swallowed. The vomitus at first contains bile, while later it becomes serous. The *appetite* is, of course, entirely lost; intense thirst prevails, the little patient drinking at every chance and following the receding glass with eager eyes. The *tongue*, moist at first, soon becomes dry and pasty; the abdomen is collapsed. The *temperature* is always high—105° or even 108° F. (40.5°–42.2° C.); and the *pulse* small and very frequent—130 to 180 beats per minute. The *breathing* is shallow and irregular, and the expression anxious and staring, but soon becomes dull. The urine becomes dark and scanty, and frequently shows the presence of acetone.

With this array of symptoms there is a striking and appalling change in the child's general appearance. Within a few hours it can scarcely be recognized; the face has become pale and pinched, the eyes and cheeks sunken, the eyelids and lips wide apart from loss of muscular control, the muscles flabby, the bones prominent, and the skin greenish or cadaverous, hanging in loose folds from the wasted frame.

Collapse comes on soon: the hands, feet, nose, and breath become cool, the respirations more unequal, and there are drowsiness and utter apathy. When life is near its close, vomiting stops, the whole surface becoming cool and clammy as the patient sinks into a state of coma, with injected eyes and contracted pupils. At last the end is reached quickly, preceded perhaps by a slight convulsion. The *duration* of the disease is short; it may prove fatal in from one to four days.

(3) *Ileocolitis*.—This may follow acute dyspeptic diarrhea, cholera infantum, or complicate the acute infections of childhood. The *symptoms* develop acutely. At the outset there may be vomiting, but it is not persistent, and the stools are greenish, feculent, often showing masses of casein. Later the discharges are increased in frequency, are small, and contain also blood and mucus. In severe cases pain and straining are distressing features. The abdomen is prominent and there is tenderness along the course of the colon. The disease presents high fever.

The *course* is variable. It may be acute—three to six days—terminating either in convalescence or death due to exhaustion. In other instances the acute symptoms subside, particularly the fever, while moderate diarrhea continues and is attended with wasting and debility. Gradual recovery may ensue, though more commonly relapses occur and death follows from bronchopneumonia or an intercurrent acute attack.

The *treatment* of *acute gastro-intestinal catarrh* divides itself into hygienic, dietetic, and medicinal measures. If a child is attacked in the city during the summer and does not yield to treatment in two or three days, it should be sent to the country or seashore. In the case of a child under two years this is absolutely imperative. Fresh air is important in all diarrheal disorders, and all cases should be kept out-of-doors as much of the time as possible. Children should be kept quiet. Bathing is soothing, insures cleanliness, and, what is very important, reduces the temperature.

Dietetic treatment is of great importance. It should be remembered that digestion is arrested in the early stage, hence to give food at this stage is to do harm. Thirst may be controlled by ice- or albumin-water, toast-water, or gum-water, with a little brandy. Buttermilk twice daily has given excellent results.

Medicinal Treatment.—The first step is directed against the acute indigestion and the active putrefaction going on in the intestines. The indication, therefore, is to empty thoroughly the alimentary tract as soon as possible, and no other treatment should be considered until this end has been accomplished. Whenever vomiting persists, the stomach should be washed. In older children emetics will favor complete emptying of the stomach, but are never to be given to infants under two years. For the intestines calomel and soda may be used; for the colon, irrigation: this is advisable in all cases, as it hastens the effect of the calomel, and removes at once much irritating and offensive material. At this time bismuth, as per the following formula, for a child two years of age is useful:

R. Bismuthi subnitratis, 3j (4.0);
 Liquor antiseptici, f3ss (15.0);
 Misturæ cretæ, q. s. ad f3ij (60.0).—M.
 Sig. "Shake." Teaspoonful in water every two hours.

Opium should not be used until the whole intestinal tube is cleansed, and then cautiously. Spirits of chloroform, or camphor, is a better remedy for the pain than opium in any form. In older children the hypodermic injection of morphin and atropin in appropriate doses frequently controls the symptoms. Bowles has used lactic acid in the maximum dose of $1\frac{1}{4}$ grains (0.08) every hour, and found it to control the symptoms in from twenty-four to forty-eight hours. Thus far the results of serum treatment have been disappointing.

Treatment of Cholera Infantum.—In this form of infection of the intestinal tract we are likely to forget that we are called upon to treat a case of acute poisoning. The toxic material acts both powerfully and quickly as a cardiac and systemic depressant. It also acts toxically upon the nerve-centers, and paralyzes the vasomotor nerves. According to Holt, the leading indications are: (a) to empty the stomach and intestines; (b) to supply the body with fluid to offset the great loss by vomiting and purging; (c) to counteract the effect of the poison on the heart and the nervous system; (d) to reduce temperature, and (e) to treat the symptoms as they arise. In the first condition thorough stomach and intestinal cleansing is absolutely necessary. Moreover, we cannot depend on emetics or purgatives to arrest pain and to limit the effect of the poison on the nervous system; a hypodermic injection of atropin and morphin is essential. Morphin must be given with discrimination to young children, especially when the vomiting and purging are slight; it is especially contraindicated when stupor or collapse seems near. Small doses repeated are better than larger single doses. Holt gives gr. $\frac{1}{100}$ (0.0006) of morphin, with gr. $\frac{1}{800}$ (0.0008) of atropin, as the first dose in a child one year old. In supplying fluid to the exhausted tissues it is useless to attempt to give them by the mouth, or even by the rectum, as by both avenues it would be rejected. An injection into the cellular tissues of the buttocks, back, or thighs of a saline solution (40 grains—2.59—of common salt to a pint of sterilized water) is the best way to meet the drain. One pint ($\frac{1}{2}$ liter) may be used every twenty-four hours, and larger quantities may often be used with advantage. Baths must be given to control temperature, and ice-bags should be placed to the head. Ice-water injections will aid in the ~~re-~~ ^{re, and ice-}

suppositories act efficiently when the water is not retained. Stimulants may **be** given hypodermically. During the active stage nothing should be allowed **by** the mouth except iced brandy or champagne.

The dietetic management and internal treatment of *ileocolitis* are similar **to** that of the preceding variety. A dose of castor oil or of calomel is to be **promptly** administered and followed in a few hours by copious irrigations **of** the colon, preferably with tepid saline solution (strength 7 : 1000). Later **a** small quantity of a thin starch solution, to which $\mathfrak{m}\mathfrak{j}$ to $\mathfrak{i}\mathfrak{i}\mathfrak{j}$ of laudanum has **been** added, may be gently thrown into the rectum, to be repeated once or **twice** daily. After the acute stage is over a weak silver nitrate solution may **be** employed.

CELIAC DISEASE

(*Diarrhœa Alba; Diarrhœa Chylosa*)

Definition.—A form of intestinal catarrh marked by copious fetid and **frothy** discharges resembling gruel.

Pathology.—Although ulcers have been noted in the intestine, the **pathol-**
ogy of the disease is not known. Says Osler: This affection resembles some-
what the disease in adults known as “hill diarrhea” or the “white flux” of
India.

Etiology.—The disease is limited chiefly to children from one to five years
old. The *Filaria sanguinis-hominis* has been found in the feces in cases of
diarrhœa chylosa.

Symptoms.—The disease is of slow development, and the character-
istic feature consists of copious *diarrheal* (though not watery) *stools*, resembling
gruel or oatmeal-porridge. These are also frothy (*frog-spawn*) and horribly
fetid. The *physical signs* consist of a moderate distention of the abdomen
and a boggy sensation that is imparted to the palpating finger. The *general*
features may be summated in gradually increasing emaciation, debility, and
pallor. The disease terminates fatally as a rule.

The **treatment** is purely symptomatic unless the presence of parasites
be suspected, when large antiseptic enemata should be given.

PHLEGMONOUS ENTERITIS

This is a suppurative inflammation of the submucous layer of the intestines.
It is among the rarest of grave maladies, especially as an irrelative disease.
It may be diffuse or take the form of a circumscribed abscess. Rarely it oc-
curs as a complicating condition in septicopyemia and in malignant types of
the exanthemata, resulting in the formation of abscesses that usually have
their seat in the duodenum. Phlegmonous enteritis may be secondary to
strangulated hernia or intussusception.

Symptoms.—The *local signs* simulate closely those of peritonitis. Among
the symptoms *vomiting* is prominent, though not diagnostic; it is always severe
and may become stercoraceous. *Pain* and *tenesmus*, when due to obstruction,
are intense. Rigors more or less severe have been observed. The *temperature*
is high, and its curve is somewhat typical of the fever of suppuration. The
disease is very fatal, the patient passing from a condition of extreme prostration
to one of utter collapse.

Treatment.—The physician's task is confined to an attempt to support
the powers of the patient and to relieve his inordinate suffering. The surgeon's
aid should be invoked early in cases of obstruction.

CROUPOUS OR DIPHTHERITIC ENTERITIS

Definition.—An intense inflammation of the intestinal mucosa, accompanied by a croupous exudate; it occurs in connection with a variety of conditions. If from any cause the epithelial covering is destroyed, agents that set up local inflammation may excite a croupous exudate.

Pathology.—There are two sets of morbid lesions to be distinguished: (1) The first and most important class exhibits a croupous deposit varying greatly in thickness and in area. Its color is variable, being sometimes of a *grayish* or *grayish-white hue*, frequently *grayish yellow*, and rarely *blackish*. I have almost invariably seen these lesions in the colon. (2) In the second group the solitary follicles alone are inflamed and covered with diphtheritic deposit.

The *etiologic* factors may be: (a) mechanical irritants (impacted feces, intestinal sand, gall-stones); (b) chemical irritants (ammonia, acids, mercury, arsenic); (c) secondary to acute infectious and certain chronic complaints (Bright's disease, pyemia, carcinoma, diabetes, tuberculosis, and anemias).

Symptoms.—When mechanical irritants give rise to symptoms they do not differ from those due to stercoral ulcers, and there is no way of recognizing the croupous deposits unless they be discharged *per rectum* and are detected in the stools. In cases that arise from the action of irritant poisons vomiting and purging are well marked and the dejections contain blood-stained mucus. We cannot be certain about the presence of croupous deposits in toxic cases unless they be found in the discharges. When phlegmonous enteritis occurs as a complicating condition in infectious diseases the symptoms are almost completely veiled. The symptomatology of the follicular variety cannot be separated clinically from that of follicular ulceration.

The **treatment** is that of the causal conditions or affections.

SPRUE

(*Psilosis*)

This has been defined as “an insidious, chronic, remitting inflammation of the whole or part of the mucous membrane of the alimentary canal, occurring principally in Europeans who are residing or have resided in tropical or subtropical climates” (Manson). It occurs in the Southern States of this country, where it is frequently confused with pellagra (*vide* p. 444), and has been most carefully studied by Bailey K. Ashford in Porto Rico and Edward J. Wood in this country.

The principal **morbid changes** consist in patchy or general destruction “the surface of the mucosa in all degrees, from slight erosions to complete disintegration of the villi, glands, and follicles.” Congestive, catarrhal, ulcerative, and cirrhotic changes may all be combined.

Etiology.—Ashford states that Bahr's opinion that sprue is due to a Monilia is correct, and has described a Monilia X, which he claims is constantly present. Residence in hot climates and previous affections of the alimentary tract are the main predisposing causes.

The leading **symptoms** are, according to Manson, irregular action of the bowels, and the passage of copious, pale, drab-colored, yeasty looking, foully smelling stools. The complexion is dark or muddy; there is emaciation and the abdomen is distended. Weakness, loss of memory, and irritability of temper are common. The oral cavity is inflamed and the seat of erosions, cracks, and superficial ulcerations. Wood¹ calls attention to the fact that the tongue in sprue is quite different from that of pellagra. In the former dis-

¹ Jour. Amer. Med. Assoc., 1919, lxxiii, 165.

it is paler, more flabby, less pointed than in the latter, while in sprue it also approaches the cobble-stone appearance. The blood-picture shows an intense anemia with a high color-index and with a marked preponderance of oversized erythrocytes. Schmidt's hydrobilirubin test was very weakly positive in 3 cases (Hiatt and Allan¹). Brunton has pointed out that Indian Hill diarrhea differs from sprue in that soreness of the mouth and anus is absent in the former.

Early appropriate treatment, which is principally dietetic (milk diet) and hygienic, checks the progress of the disease.

CHOLERA MORBUS

(*Cholera Nostras; Sporadic Cholera*)

Definition.—A self-limiting disease, characterized by serous vomiting and purging, colicky pains, and often muscular cramps.

Pathology.—No constant anatomic changes have been noted. They are analogous to those seen in acute gastro-enteritis, though cases have terminated fatally in which no morbid lesions were found *postmortem*.

Etiology.—Among predisposing causes, the *age* and the *season* exert the most prominent influence. The condition may appear in subjects under two years, when the term "cholera infantum" is employed; but it is oftener met with in older children and adults. It is almost invariably seen during the heated term in temperate zones, from the latter part of June to September, and is especially prevalent during the months of July and August. Bad hygienic environment, foul air in particular, has a noticeable effect, and, though not as yet absolutely proved, it may be safely inferred from the symptomatology and general clinical course of the affection that it is of microbic origin. Among other factors are improper food, particularly unripe fruit, cucumbers, egg-plant, and exposure to cold and wet. Various *organisms* (especially the Finkler and Prior spirillum) have been found present. Virulent specimens of the *Bacillus coli communis*, and even of the streptococcus, have been noted.

Clinical History.—The *onset* is often sudden, and is marked by abdominal pain, vomiting, and diarrhea. At first the *vomit* consists of food, and later of bile and mucus. The *dejections* are fecal in character at the onset; though they soon become watery, and may resemble the rice-water stools of Asiatic cholera.

Physical examination reveals only tenderness on pressure over the abdomen, and particularly over the epigastric region.

General Symptoms.—Cramps in the calf muscles are common. The temperature varies greatly, ranging from 100° to 106° F. (37.7°–41.1° C.). The skin surface, however, and more particularly that of the extremities, feels cool, and owing to this fact the rectal temperature should be recorded. The pulse becomes rapid and feeble as the case progresses. The face is pale or even cyanotic, and the features look pinched. The extremities lose their plumpness, and the patient usually appears prostrated and mentally dull. The urine is scanty, high colored, and sometimes albuminous, and thirst is extreme. There is a group of cases that develop subacutely, and in these the symptoms tend to persist.

Differential Diagnosis.—The symptoms of cholera morbus resemble so closely those of *Asiatic cholera* as to preclude the possibility of a differential diagnosis from the symptoms. A bacteriologic examination of the stools, however, permits a certain discrimination; and during a cholera epidemic the distinction between these affections is thus made. The effects of certain direct irritants, as in poisoning by ptomaines and toxic doses of arsenic, must be excluded by the history.

¹ *Jour. Amer. Med. Assoc.*, August 1, 1914.

Prognosis and Duration.—The duration of the disease varies from three to four hours to two days. It is rarely fatal, though in persons suffering from such chronic affections as Bright's or cardiac disease, and also in the aged, the prognosis is only guardedly favorable. An element of danger is profound collapse. Otitis media is occasionally seen, although most cases without sequelæ recover.

Treatment.—The *diet* must be rigorously restricted, and predigested milk and animal broths are to be prepared as lightly as possible until convalescence has been fairly established. The comfort of the patient is much enhanced by keeping him at absolute rest. *Local measures* are useful in combating pain and vomiting. A large mustard-paste applied to the stomach and abdomen, followed by linseed-poultices that are to be worn constantly, has a strong influence in accomplishing the relief of the symptoms before mentioned. If indigestible substances have been taken prior to the attack, prompt though mild laxatives are to be given at the beginning of the treatment. For the excessive thirst chipped ice, over which a little brandy has been sprinkled, is effective. For controlling the morbid sensitiveness, on which the pain, nausea, and the diarrhea depend, we have a remedy *par excellence* in the hypodermic administration of morphin. The dose should vary (gr. $\frac{1}{4}$ to $\frac{1}{2}$ —0.016–0.032) according to the severity of the symptoms, and I have rarely found it necessary to give a second dose. Not only are the pain and diarrhea subdued, but the circulation is re-established. It has also been recommended to administer opium by the mouth for these symptoms, but the results are less satisfactory. The other points in the treatment of this affection are identical with those discussed under the treatment of Gastric and Enteric Catarrh.

INTESTINAL INFARCTION

A few instances of occlusion of the superior mesenteric artery by an embolus have been recorded recently. The condition produces hemorrhagic infarction of the small intestines, and is marked by grave and usually fatal symptoms. Its *causes* are sometimes obscure. The cases that have come to autopsy have shown intense congestion, with a swollen, blood-infiltrated state of the jejunum and ileum. Osler has seen three instances: in one there were numerous vegetations on the mitral valves from which the embolus was probably derived; in another the superior mesentery was plugged at its orifice, and in the third the artery was blocked by a portion of the fibrous clot of an aneurysm of the aorta near the diaphragm. The *symptoms* are urgent. Quite often diarrhea is present from the first, the dejections sometimes becoming blood tinged. Soon the characteristically grave symptoms of intestinal obstruction supervene—viz., *great pain, vomiting, and constipation* (less commonly diarrhea), with *tympanitic distention* of the abdomen (generally). The condition cannot be recognized from the symptoms on account of their resemblance to the various forms of obstruction, yet its probable existence may be inferred from the presence of the known causes.

INTESTINAL ULCERS

FOLLICULAR ULCERS have already been described under Catarrhal Enteritis (*vide* p. 805), and they have a similar pathology and etiology. When present in goodly numbers they give rise to a symptom peculiarly their own, and hence

may be dignified by a separate though brief mention. The *symptoms* of the condition arising in the course of chronic enteritis often escape observation for a long time. The most characteristic manifestation is the appearance in the stools of conical shaped masses of mucus resembling "boiled sago." Marked weakness and emaciation rapidly ensue. Among children the disease is common and assumes an aggravated form, the little sufferers quite frequently reaching their end as the result of inanition. An unfavorable termination may be due to perforation followed by suppurative peritonitis. The *treatment* coincides with that of chronic enteritis.

STERCORAL ULCERS are the result of the mechanical effect of hard fecal scybala (often enteroliths, due to a deposit of lime-salts) upon the intestinal mucous membrane. They occupy the sides or tops of the normal folds in the colon.

Symptoms.—There is, as a rule, a clear history of *chronic constipation*, though the physician is often called on account of the presence of *diarrhea*; this is caused by the retained hardened feces finding their way into the rectum. A *digital exploration* will now clear up the diagnosis. There are *tenesmus* and *colicky pain* in the abdomen, the latter symptom being also complained of when diarrhea is absent. The pain often occurs in severe paroxysms that may be attended with the discharge of flaky mucus, pus, and sometimes blood. Enteroliths may lie in the intestines for years together, or they may finally be discharged with the stools. The ulceration that is thus caused often passes unrecognized.

Physical Examination.—Palpation may reveal the presence of a sausage-shaped tumor and localized tenderness over the seats of ulcers.

The **prognosis** is good if the condition be not overlooked.

The **treatment** consists in thoroughly evacuating the bowels by salines and simple enemata, persistently used. Subsequently these cases are to be treated as other non-specific ulcers of the bowels.

SIMPLE ULCERATIVE COLITIS is a not uncommon complaint, and one that is frequently associated with chronic intestinal catarrh. The ulcers may be quite extensive, removing the greater portion of the mucous membrane, though I observed several cases at the Episcopal Hospital that were superficial. The muscular layer of the gut was greatly hypertrophied and its lumen increased in all. The non-ulcerated portions of the mucosa looked, in part, quite pale, and in part quite dark.

The **etiology** is obscure. The disease is met with most frequently in persons past middle life, and it is quite probable that chronic enteritis sustains a causal relation. Those whose constitutions have been enfeebled by previous disease or an improvident hygienic environment are the chief sufferers.

Symptoms.—The clinical features are ill defined at the onset, and are often erroneously ascribed to indigestion. *Diarrhea* (lienteric in character) is its most prominent symptom, and with it constipation may alternate. Pus and blood are usually absent. The general health soon suffers greatly, the patient becoming weak and emaciated.

The **course** of the disease is subacute, tending to become chronic.

The **diagnosis**, apart from a consideration of the symptoms above mentioned, requires the elimination of *dysentery*—an easy task, as a rule. The disease resembles closely the amebic form of dysentery, hence in dubious cases a microscopic examination of the feces should be made.

Prognosis.—This is unfavorable during the earlier stages in the aged. The tendency to chronicity of the disease must be considered.

The **treatment** embraces: (a) a careful regulation of the diet, consisting in a restriction of the patient to liquids and semisolids during the acute stage;

(b) the administration of a gentle laxative, followed by antiseptics and astringents (bismuth gr. xxx—2.0—combined with phenyl salicylate gr. v—0.324—every four hours); (c) the more serviceable local measures in the form of enemata among the best being silver nitrate (gr. $\frac{1}{4}$ ad \mathfrak{zj} —0.016—32.0) or creolin (2 per cent.).

SOLITARY ULCERS.—"Two instances of ulcer of the cecum, both with perforation, have come under my observation, and in one instance a simple ulcer of the colon perforated and led to fatal peritonitis" (Osler).

The **DIFFUSE CATARRHAL ULCER** is inseparable from acute enteritis; the **CANCEROUS ULCER**, **TUBERCULOUS ULCER**, and **AMEBIC ULCER** are alluded to under their respective heads.

APPENDICITIS

Definition.—A catarrhal, ulcerative, or interstitial inflammation of the appendix vermiformis. It must be confessed that, according to our present views, appendicitis is a surgical rather than a medical affection, particularly from the standpoint of treatment. Knowing from personal experience and observation, however, that general practitioners are constantly meeting with cases of appendicitis, its prompt clinical recognition by the latter is not only a matter of interest, but also of great practical importance for two reasons: First, in order that surgical intervention can be instituted at the proper moment; and second, because appendicitis is the leading serious disease of the intestinal tract.

The term "appendicitis" includes the affections *typhlitis* (inflammation of the cecum) and *perityphlitis* (a similar involvement of the connective tissue behind the cecum) by reason of the fact that with few exceptions when the symptoms of the latter affection are presented the appendix vermiformis is the part primarily affected. To the physicians and surgeons of America belongs the credit of having first established the truly important rank of appendicitis.¹

Anatomic.—Without any known function the human appendix vermiformis represents the remains of the enormous cecum of inferior animals, especially rodents and herbivora. Clado asserts that the vermiform appendix is kept in position by two folds of peritoneum, a meso-appendix, which is attached to the iliac fossa, and a second fold, perpendicular to the first, which is attached to the posterior portion of the small intestine. A lymphatic gland generally occupies the angle formed by the appendix, cecum, and the small gut; this receives all the lymphatic vessels of the appendix. In the female a lymphatic connection may exist between the appendix and the right ovary. The size of the appendix varies greatly. Ferguson, after measuring 200 appendices, gave as the average length $4\frac{1}{2}$ inches (11.4 cm.), and as the diameter that of a No. 9 English sound—about $\frac{1}{4}$ inch (0.63 cm.) Berry's studies, which are partly based upon personal examination of 100 bodies, and partly upon comparison of his own results with those obtained by other investigators, gives the average length in all the observations as 9.2 cm. (3.6 inches). The caliber is ordinarily of the size of a goose-quill. Very exceptionally, as in a case reported by Swan, there is a congenital absence of the appendix. Its two fibromuscular coats (external longitudinal and internal circular) are thick; its mucous membrane contains lymphoid elements in abundance. The blood-supply is derived from the ileocolic artery at the valve, a single branch running to the end of

¹ The following names will long be connected with this disease: Pepper, Fitz, McBurney, Porter, Willard Parker, Weir, Sand, Bull, Warren, Keen, Morton, White, Price, Deaver, Senn, and many others.

the appendix, while the nerves are derived from the superior mesenteric plexus of the sympathetic. Shortly after middle life the cavity of the appendix becomes obliterated. Its blind extremity points most frequently toward the spleen. The appendix may lie behind the cecum, and sometimes partly to its inner side, its tip almost touching the liver or the gall-bladder. In not a few instances it dips downward, passing over the brim of the pelvis. There is no adjacent organ to which it may not become adherent, and in rare instances it is twisted like a loop around the small gut, causing constriction or even strangulation.

Pathology.—Three pathologic varieties are recognized:

(1) **Catarrhal or Obliterative Appendicitis.**—This may be acute or chronic. The term "catarrhal inflammation" is still retained, though scarcely applicable, since, as a rule, appendicular inflammation tends to spread quickly to all the coats, including the serosa. Obliterative appendicitis is descriptive and in every way preferable. The *mechanism* of the inflammation is briefly as follows: The mesentery being too short, the exit is too small, and in consequence of swelling of the coats (especially the mucous) the venous return is greatly impeded, then the arterial, followed often by abscess formation. In the female a branch is supposed to be furnished by the ovarian artery, making a more perfect blood-supply. The appearances are, in the beginning, identical with those of catarrhal inflammations elsewhere in the bowel. Within twenty-four hours all the layers are swollen, with marked cellular infiltration, causing the appendix to become firm and often rigid. The mucosa may be denuded of its epithelium and present a granular surface. The external coat (serosa) is usually hyperemic, and not uncommonly the seat of fresh or old adhesions. The tube may become completely obliterated by pressure, resulting in a union between the granular surfaces, in this manner rendering subsequent attacks impossible (Hawkins). It is in cases in which this fortunate result is not reached, however, that acute appendicitis leads to the chronic form with relapses. Two additional terminations may be observed: First, an obliteration of the lumen may occur near the valve, in which case the appendix becomes dilated, and sometimes enormously so (cystic). The contained liquid may be either serous or purulent. Second, obliterative appendicitis may lead directly to ulceration of the mucous membrane, and often in the absence of a fecal concretion or foreign body. Again, the cystic appendix may ulcerate, with or without perforation. Obviously, the more marked the stenosis of the appendix, the less favorable the conditions for natural drainage, and the greater the liability to recurrences of attacks of appendicitis. This variety then may end in resolution, complete obliteration, stenosis, or ulceration, and the latter sometimes in perforation.

(2) **Ulcerative Inflammation.**—Like the preceding, this variety may be acute or chronic. It may be a sequel of the obliterative form, and often accompanies chronic obliterative appendicitis. More commonly, however, it is seen in connection with concretions, and sometimes with foreign bodies also. By no means invariably, however, does the presence of these substances excite ulceration of the appendix. Micro-organisms play an important rôle in this variety (*vide* Etiology). The submucosa or muscularis usually forms the base of the ulcer. The termination may be in healing, with tendency to stricture. Again, the ulcer may extend in depth until perforation occurs.

(3) **Interstitial or Parietal Inflammation.**—This may be preceded by the obliterative or the ulcerative form, which may be followed by anemic necrosis and sloughing. Concretions or foreign bodies are often found, and specific bacteria are of greater etiologic importance. The grave and hence the most important lesions are the gangrenous, limited to a circumscribed part of the tube. Interstitial

single termination—perforation—and leads to appendicular peritonitis of a virulent and infectious type.

It may be that neither necrosis nor gangrene may supervene. When perforation occurs, one or more openings, ranging in size from one to several millimeters, may be observed, while the remainder of the appendix may present no abnormalities; more often, however, it is blood-injected and swollen. The appendix may slough *en masse*. The histopathologic changes may be characterized by intense cellular exudation, necrosis, or purulent inflammation. Pathologically considered nearly all cases are suppurative. The muscular coat is hypertrophied, and chronic thickening of the appendix may result.

Consequences of Perforation.—A common result of all forms of appendicitis is a localized peritonitis, and this is a constant effect of the severer forms, either leading to (a) circumscribed peritonitis or to (b) acute diffuse peritonitis.

(a) *Circumscribed Peritonitis.*—At first the surface of the peritoneum is opaque and velvety. Soon a fibrinous exudation covers the appendicular peritoneum, and quickly establishes adhesions between the appendix and the adjacent parts (abdominal wall, intestinal coils). The process may not proceed any further. Generally, however, it is soon followed by a serous or sero-fibrinous exudation, which becomes sero- or fibrinopurulent, and often forms the so-called perityphlitic abscess. The seat of the abscess is always near the tube, and is as varying as the position of the appendix; its size is also extremely variable, as it sometimes contains enormous amounts of pus. Among the most common locations are—McBurney's point, the vicinity of the cecum, the coils of the small intestines (near the umbilicus), and, more rarely, in the pelvis below. The pus contained in the abscess is rarely thick, grayish-yellow in color, and emits a fecal odor; more commonly it is thin, turbid, dark gray or greenish in color, and has an extremely fetid or even gangrenous odor. The process of gangrenous sphacelation *en masse* is often completed after the limiting wall of adhesion has formed, when the entire appendix is found free in the pus cavity.

The abscess may be *subperitoneal*, as when perforation occurs into the retro-cecal connective tissue, and the term "iliac abscess" was formerly applied to these *extraperitoneal* purulent collections. They are rare, however, since the early operation has been employed. Their situation and dimensions depend upon the direction taken by the appendix. The latter may pass downward, and the pus is then apt to accumulate in the lower part of the iliac fossa, and may point and finally burst in the neighborhood of Poupart's ligament, with subsequent recovery. Occasionally under these circumstances a fistula remains for an indefinite period of time. The appendix may touch various abdominal structures, and the pus in following the line of least resistance may cause spontaneous rupture into the rectum, bladder, or the vagina when it points inward; and into the perinephric region or into the pleural cavity (through the diaphragm) when it points upward; or even into the cecum or colon. The contents of the abscess may also find their way through the abdominal wall in the vicinity of the umbilicus. The psoas muscle may conduct the abscess downward, and it may then point at the hip-joint or gain the gluteal regions or the scrotum, producing the so-called "scrotal appendicitis." The appendix has also been found in a hernial sac. Among the rare lesions to be noted are erosion of one of the arteries of the iliac region (causing fatal hemorrhage) and pylephlebitis. From the thrombi in the mesenteric veins in the latter condition infectious emboli may be conveyed to the liver, giving rise to hepatic abscess; this occurred in a case of my own at the Episcopal Hospital, Philadelphia. The abscess may also be due to an extension of the thrombophlebitis of the mesenteric veins that lead from the appendix to the portal vein. Thrombosis of the iliac veins with edema of the corresponding

leg may also arise, and these veins may, during the process of healing, become compressed, with a resulting edema of the leg, as in 2 of my cases. It rarely happens that suppurative processes are both extra- and intraperitoneal.

(b) *Acute Diffuse Peritonitis*.—This follows perforation when previous adhesions have not taken place, or when, having formed, they yield. Generalized peritonitis may also follow the circumscribed form, the lesions being propagated to the entire membrane by extension. The morbid changes are described under Acute Peritonitis (*q. v.*). Since the early operation has been employed peritonitis has been the result, usually, of direct perforation before protective adhesions have been formed.

Etiology.—Predisposing Causes.—(a) Doubtless certain *congenital structural defects* aid in the production of appendicitis. Among them are unnatural length, location, and arrangement of the organ; also the shape of the meso-appendix and Gerlach's valve. These factors tend to obliterate the lumen of the canal by producing kinks and twists, thus favoring the collection of material within the appendix. (b) *Strictures*, particularly near the cecal end of the tube, and old adhesions, especially peritonitis, operate in the same manner as (a), only with greater power. (c) *Fecal concretions* are the main cause in nearly one-half, while *foreign bodies* play a small rôle, having been present in 7 per cent. only of 1400 cases (J. F. Mitchell). The calculi form in the appendix itself (Rochaz). The foreign bodies are very various, and consist of seeds, worms, gall-stones, pills, bristles, and, more rarely, pointed bodies, as fish-bones or pins. The presence of fecal concretions and foreign bodies is often tolerated by the appendix without symptoms or local pathologic changes; hence they are looked upon rather as a predisposing than as an exciting cause. (d) *Ulcers* (tuberculous, typhoid, and, rarely, actinomycotic) may also produce this affection. (e) *Straining Efforts and Traumatism*.—Not uncommonly excessive muscular exertion, traumatism, or jarring of the body, as in jumping, act as favoring causes. (f) *Age*.—The disease is especially frequent in young adults between the fifteenth and thirtieth years. It is not infrequent in childhood after the third year, and it has been seen in persons over seventy years of age. (g) *Sex*.—Appendicitis attacks males oftener than females (4 to 1); this fact has been explained (*vide supra*). In the female it is rarely of adnexal origin. Adhesions between the tube and ovary and the appendix may occur, the morbid process then extending to the latter. (h) *Gastro-intestinal Disturbance*.—Indiscretions in the diet may precede a primary attack, and are of paramount etiologic importance in the recurrent forms of the malady. (i) *Heredity*.—That this plays a rôle in cases of appendicitis I have long felt convinced. This serves to explain cases in which syphilis, rheumatism, and uricacidemia seem to act as causal agents. (j) Evidence to show that influenza and other affections may cause appendicitis is not wanting. (k) It is not improbable that *poor blood-supply* and retrogression of the organ plus torsion and the like are the leading predisposing factors. Any slight interference with the circulation tends to block it, with dire consequences. (l) The negro enjoys comparative immunity. (m) The immoderate use of meat (MacLean). (n) Rosenow claims that appendicitis may be of hematogenous origin—secondary to distant foci of infection (tonsillitis, etc.).

Bacteriology.—The combined results of several experimentalists show that no special organism plays an exclusive rôle in this disease, but the studies of Hodenpyl indicate that the *Bacillus coli communis* is most generally present: it is well known, moreover, that this bacillus becomes pathogenic when it escapes into tissues in which it does not naturally belong. A. O. J. Kelly found this organism present alone in 73.4 per cent. in 94 instances of acute appendicitis; alone in 89.71 per cent. of 107 cases of chronic appendicitis. Barbacci emphasizes the etiologic importance of the ~~role~~ of the intestinal contents into

the peritoneal cavity—i. e., the chemical factor. Of other specific bacteria, those of *typhoid* and *tuberculosis* are not uncommonly found to be present. The *Streptococcus pyogenes* may also produce the most virulent infection, and the *Staphylococcus pyogenes aureus*, the *proteus*, and other organisms have been found. The great frequency of appendicitis is rendered appreciable by the numerous favoring factors (including the congenital conditons) acting upon the appendix, which naturally has an exceedingly low vitality; also by the constant presence of organisms that are known to become pathogenic in the presence of a slight lesion.

Clinical History.—Doubtless many cases are overlooked because of the extreme mildness of the symptoms. These are often attributed to intestinal indigestion or to a “cold,” to which the patient pays little attention unless he displays unusual susceptibility.

The *onset* of acute appendicitis may be slow and gradual, but oftener it is *quite sudden*. A clear history of some obvious cause (an error in diet or muscular effort) may be obtainable. Again, preceding the onset of the definite symptoms and extending over a day or two, there may have been *certain prodromes*, as impaired appetite, nausea, constipation, or diarrhea. In slow cases the local and general symptoms are at first slight, but gradually increase in severity. Indeed, in the latter class the patient may go about his customary duties during the attack with ill-defined rational symptoms, while in reality suffering from periappendicular abscess. These patients run two serious dangers—first, spontaneous rupture of the abscess into the peritoneal cavity may occur; and second, the slow septic absorption may suddenly overwhelm the system. As a rule the sudden cases develop in seeming perfect health, and are sometimes heralded by a rigor or chilliness.

The characteristic features of the invasion are *abdominal pain, fever, tenderness over McBurney's point, circumscribed resistance, gastric disturbances*, and, as a rule, constipation. The *pain* varies in intensity from a mere feeling of soreness to that of the most agonizing suffering. It may be paroxysmal, though oftener it is constant, with moderate exacerbations. Severe pain points to an involvement of the peritoneum and signals a danger of perforation. At first the pain may be referred to any point in the abdomen for the reason that the superior mesenteric plexus, that furnishes the nerve supply to the appendix, sends numerous twigs to the small intestines; later, within forty-eight hours, it becomes more distinctly localized in the ileocecal region.

Elevation of Temperature.—The exacerbations may at first touch 102°, 103°, or even 105° F. (38.8°–40.5° C.), and particularly in children; more commonly they range from 100° to 102° F. (37.7°–38.8° C.). The degree of fever is unreliable, however, as a criterion of the severity of the case, since the worst cases may show a subnormal temperature.

An elevation of temperature, however trivial, is most significant, pointing as it does to inflammation as the cause of the local symptoms. The pulse-rate is somewhat higher than the elevation of temperature would lead one to expect, and in bad cases the pulse is usually much quickened. Sometimes, however, it remains at 80 to 90 per minute, and may be full and soft, even though the patient be practically moribund.

Fixed *tenderness* is practically constant on pressure over a limited area, midway on a line between the anterior superior iliac spine and the umbilicus (*McBurney's point*), and is a valuable sign. The seat of the tenderness may be found at other points rarely, depending upon the location of the appendix. I have twice observed it in the lumbar, once in the right hypochondriac region, and once far below the usual point, in the right iliac fossa. Brun¹ finds a tender point just above the middle portion of the right iliac crest to be quite common

¹ *Presse médicale*, 1919, xxvii, 23.

when the inflamed appendix is retrocecal, while frequently the muscles of the posterior abdominal wall are more rigid than the anterior muscles when the appendix is in this position. It has been found in the umbilical and left iliac regions, in the pelvis, and in the groin. In several instances, although I have found it elsewhere in the early stage, it has shifted to McBurney's point later. On the other hand, it may move from the usual position in cases that are allowed to drag on. When the sensitive area is at McBurney's point, as is the rule, the gentlest pressure often suffices to elicit exquisite tenderness, but when it is situated elsewhere firmer pressure with the finger-tips is usually required. Deep pressure always reveals localized tenderness at some point in the abdomen if the case is one of appendicitis. *Palpation* also detects an abnormal rigidity of the right rectus abdominis muscle. On or about the second day a *circumscribed induration* manifests itself, followed soon by a fulness and swelling tending to obliterate the depressions above and in front of the anterior iliac spine. The position of the indurated area varies according to the location of the appendix. Sometimes a questionable mass the shape of an enlarged appendix is palpable. In such cases peritoneal

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*

*

C.

Fig. 53.—Temperature-chart of a case of appendicitis. M. M.—, aged thirty-five years, motorman. Laparotomy, by Prof. E. Laplace, disclosed catarrhal appendicitis with adhesions.

exudation has not as yet occurred to any great extent. Induration may gradually assume the circumscribed form; it may, moreover, be so deeply seated as not to be appreciable. The degree of tenseness of the two recti muscles—right and left—should be compared, though an absence of tension of the right rectus does not eliminate appendicitis. The results of *percussion* furnish no certain guide.

Vomiting usually occurs at the beginning unless there be diarrhea, and is attended by more or less nausea; it may continue throughout the course of the attack. In most cases after a few paroxysms of vomiting the symptom disappears, although it may recur if errors in diet be committed or if peritonitis supervene. Constipation is the rule during the attack, though diarrhea, which sometimes precedes appendicitis, may also occur at a late stage as a septic symptom. There is anorexia and the tongue is coated. The *decubitus* is dorsal, with the right leg flexed. Frequent micturition (early) and retention of urine (later) are not uncommon, the urine having a deep color tint, and sometimes containing albumin. Moderate leukocytosis (*e. g.*, 10,000 to 15,000 per cubic

well as the local symptoms may abate, and the patient leave his bed, carrying with him, however, the abscess. The latter may point somewhere in the right lower quadrant of the abdomen or in the lumbar region. Spontaneous rupture into the rectum, bladder, vagina, or cecum may also occur. Often, preceding the discharge of pus into these organs, the latter display marked irritability, particularly the rectum and bladder. There is always the danger that the contents of the abscess may find its way into the general peritoneal cavity. The symptoms of hepatic abscess may develop. The pus may traverse the abdomen in the upward direction until it touches the diaphragm, when the symptoms of subphrenic abscess may be manifested. Extension through the diaphragm, causing pleurisy or pericarditis, and a pleurofecal fistula may occur.

C.

Fig. 54.—Temperature-chart of a case of appendicitis. R. C.—, aged nineteen years; carriage-builder. A peritoneal abscess was found, while the appendix was becoming gangrenous.

The lung complications originate, as a rule, from emboli. Sonnenburg found that out of 740 cases of appendicitis, 28 had some lung complication, and of these, 14 were cases of thrombosis. The early recognition of the postoperative lung emboli is important.

The general symptoms undergo a modification, due to the *suppurative process*. Rigors or a decided chilliness may occur. Diarrhea often succeeds to previous constipation, and drenching sweats to a dry skin. Improvement and even spontaneous cure may ensue if spontaneous rupture into one of the outlets of the body should occur. The fever (Fig. 54) may be either remittent or intermittent, and if the localized inflammatory process be active, the usual pronounced features of septicemia are predominant in the clinical picture.

The latter specially grave condition often drifts into an extreme typhoid state with a hopeless course.

Diagnosis.—Typical cases of appendicitis are readily diagnosed. Their recognition rests upon a few cardinal symptoms—viz., the acute development of severe pain in the right iliac fossa, coming on in a person previously healthy and usually under forty years of age; appendicular tenderness, unilateral induration, fever, vomiting, and constipation, or, more rarely, diarrhea. Atypical cases, however, may offer difficulty, although it is my belief that errors in diagnosis are less frequent than in almost any other disease. The pain may for a time be referred to a circumscribed area far removed from the site of the appendix, and rarely it continues without a change of situation throughout the attack. In the latter case the morbid lesions may occupy the usual position, or more often perhaps some quite unusual position. Thus, when the pain is referred “due east,” or to the left iliac fossa, with bilateral induration, the appendix will be found in the pelvis (Deaver). In such instances a rectal and bimanual vaginal examination are imperative. It should be an unvarying rule in all cases of severe abdominal pain to palpate with the fingertip every square inch of the abdomen if necessary, to find the localized tenderness when it is not found at McBurney’s point. The degree of tenderness sustains a close relationship to the severity of the local inflammation as long as the condition remains strictly localized, but this relationship is lost when generalization occurs. Pain following rapid removal of the hand after it has been applied to the spot to induce pressure (Blumberg’s sign) is confirmatory. It is not, however, a specific sign, Nikolaieff having found it in every case of peritoneal irritation. With the appearance of a circumscribed induration and of the intense local tenderness and pain it is reasonably sure that perforation either has occurred or is impending. Perforation may occur without local induration, however, and even after subsidence of the acute pain and excessive tenderness. Gangrenous appendicitis is *most deceptive*. The very acute symptoms, including the fever, may disappear, and unless the physician be upon his guard the patient will be considered convalescent and be allowed to go about. Rupture of the abscess now occurs unexpectedly into the peritoneal cavity, intestines, or some other direction, or a large-sized abscess develops with the usual signs and symptoms. In dubious cases the roentgen rays should be employed for diagnostic purposes.

Differential Diagnosis.—*Typhlitis, and Especially the Massing of Feces in the Cecum.*—These are truly rare conditions. According to McBurney, 99 per cent. of all typhlitic abscesses are of appendicular origin, and of 400 autopsies by Einhorn 91 per cent. had this origin. Ball and others have performed laparotomy for ulcerative cecitis, but this condition cannot be recognized during life. Stercoral typhlitis is discriminated from true appendicitis by the precedent constipation, which may become absolute, by the dragging character of the pain, the late-appearing fever, and the physical signs, which indicate the presence of a superficial, sausage-shaped tumor that is often doughy and extends vertically from a point near the right costal border “southward.” Percussion elicits dulness over the seat of the tumor. The localized tenderness and circumscribed resistance of acute appendicitis are wanting.

Renal Colic.—There is an absence of fever and of a localized spot of tenderness and induration. On the other hand, disturbed micturition followed by hematuria occurs and pain radiates into the groin and testicle.

Indigestion.—Digestive disturbances, and particularly pain and vomiting, accompany appendicitis. When they occur independently of appendicitis, however, they can be relieved, and the appendicular region remains free from fixed pain, tenderness, or tumor.

Cholecystitis with Distention.—This gives rise to a superficial, mobile, pear-shaped tumor (the distended gall-bladder), with or without jaundice—features not met with in appendicitis. The tumor in appendicitis is generally below the level of the umbilicus, but when the appendix extends upward the tip may almost touch the gall-bladder, in which case a diagnosis cannot be rendered.

Perinephric Abscess.—Without a clear history the differentiation cannot be made except by exploratory incision.

Pneumonia.—The pain in the earlier stages of pneumonia may be referred to the appendix. Physical examination will prevent error.

Acute Peritonitis Due to Ovarian or Tubal Disease.—When the appendix occupies not its usual seat in the iliac region, but the pelvic fossa, then the distinctions between salpingitis and appendicitis are not easily drawn. Right ovaritis, owing to the presence of pain, tenderness in the right iliac fossa, and fever, often closely simulates appendicitis. In the former tenderness is less pronounced and the organs of uterogestation manifest certain disturbances of function. A clear history, coupled with a careful pelvic examination, will usually complete the clinical separation of these two conditions.

Extra-uterine Pregnancy.—In this condition the menstrual history furnishes important information. There is, in addition, profound collapse, due to hemorrhage, when rupture of the adhesions occurs. Elevation of temperature is absent. The localized tenderness and increased resistance are lower in the pelvis than in appendicitis.

Acute Tuberculous Peritonitis.—As in appendicitis, so in tuberculous peritonitis, pain, tenderness, and fever are present, but in the latter the onset is more gradual, and the signs of tumor and increased resistance in the ileocecal region are absent. Movable dulness may be present in the tuberculous affection, but not in appendicitis until the peritonitis is generalized. The lungs generally show lesions in tuberculous peritonitis.

Acute Intestinal Obstruction.—When this is due to intussusception there may be signs of a tumor, but not at McBurney's point; the tenderness over the site of the mass is less intense, while the frequent bloody discharges that are seen in this condition, accompanied by tenesmus, do not characterize appendicitis. When obstruction is caused by strangulation stercoraceous vomiting is apt to occur, and is absent in appendicitis. Pain, local tenderness, and, not uncommonly, signs of a tumor appear, but elsewhere than at McBurney's point.

Intestinal Lithiasis.—This can be diagnosticated, as a rule, by the presence of intestinal sand in the movements (Bottentuit). Circumscribed resistance is absent in this connection.

Acute Hemorrhagic Pancreatitis.—This affection simulates appendicitis with generalized peritonitis. But the deep-seated epigastric pain, followed by circumscribed resistance in the same region (a grouping absent in appendicitis), should arouse strong suspicion of pancreatitis.

Hip-joint Disease.—In both hip-joint disease and appendicitis the dorsal decubitus with flexed leg is noted. If the patient be anesthetized, however, full extension of the leg and a normal condition of the hip-joint are easily demonstrable in appendicitis.

Typhoid Fever.—Mild cases of appendicitis with accompanying diarrhea bear a close superficial resemblance to typhoid fever. In typhoid fever, however, the onset is more gradual and the fever-type more continuous than in appendicitis. In typhoid the stools are somewhat peculiar, the spleen is swollen, there is dulness of intellect, bronchitis and the characteristic eruption attend—all features that are absent in appendicitis. The diazo-reaction would strengthen the diagnosis of typhoid, and a response to Widal's test would be conclusive.

the mortality is practically *nil*. On the other hand, in cases that have been allowed to drag on until general peritonitis has set in, treatment by operation is not advisable. Moreover, the most ardent advocate of immediate operative treatment is sometimes compelled to rest satisfied with medical measures. Such cases are those in which there are associated chronic affections (advanced diabetes, Bright's disease), not to speak of those in which the patient declines operation. Appendectomy alone does not cure in patients with chronic constipation, a long dilated cecum, or enteroptosis.

General Management.—The patient should be kept in bed in a quiet, well-ventilated apartment, and in no affection is the value of *absolute rest* in the treatment of inflammation greater than in appendicitis. Neither food nor drink should be allowed from the moment the patient is first seen until early convalescence. At the start, and particularly if a sausage-shaped tumor be present, intestinal irrigation, oft-repeated, with a view to removing the fecal matter, must be carried forward carefully. I avoid the use of high enemata in *progressive* cases, since they are apt to induce rupture of the sac. To relieve thirst, enteroclysis by the drop method may be employed, and when stimulants are needful, whisky or liquid meat extracts may be added to the saline solution.

As regards the use of opium professional opinion is not united, though a general tendency toward the limitation of its use to the minimum amount necessary to alleviate pain is happily noticeable; unless demanded by excessive suffering it had better be omitted altogether. When necessary, it is best administered hypodermically in the form of morphin (gr. $\frac{1}{12}$ to $\frac{1}{8}$ —0.0054–0.0081). The greatest objection to the use of opium is its effect in veiling the symptoms that assist the physician in forming a judgment as to the prospects and progress of the case. Gastric irritability may be sufficiently marked to demand special measures, such as the swallowing of small pieces of ice, spirits of chloroform, menthol, and the well-known combination of cerium oxalate (gr. iij—0.02) and cocaine (gr. $\frac{1}{8}$ —0.008) every third hour may be used.

Local Measures.—The suspended ice-bag is an excellent means of combating the pain, and often obviates the necessity of an internal use of opium. Instead of the ice-bag, cloths wet in cold water may be applied and changed every few minutes. In the early stage a few leeches may be beneficial in their effect upon the local inflammation. Blisters, however, are rarely advisable, and are particularly objectionable should the patient afterward be submitted to an operation. Mild forms of counterirritants (mustard-paste) are preferable, though these also render the skin and underlying tissues hard and leathery.

Management of Convalescence.—The patient should not be allowed to leave his bed for several days after the disappearance of all symptoms; even the mildest forms of exercise should not be undertaken for at least one week subsequent to getting out of bed. During convalescence the diet must be carefully guarded, and the bowels, at all hazards, kept in a soluble condition. It is questionable whether drugs will aid in the absorption of the exudate or assist in resolution.

DIVERTICULITIS

An inflammatory process of a diverticulum from the intestinal canal sometimes occurs, either as an acute or a chronic intra-abdominal condition, with symptoms that are often very vague. The lesion is usually situated in the left lower quadrant of the abdomen, the diverticulum opening out from the sigmoid. The acute *symptoms* closely resemble appendicitis: pain, tenderness, rigidity, fever, leukocytosis, but with the local symptoms on the left instead

INTESTINAL CALCULI

Intestinal calculi are rarely passed with the feces, and may be in the form of small concretions, hepatic calculi that have entered the intestine, and as sand which is formed in the saccules of the colon and folds of the cecum and rectum. Their origin may depend upon the deposition of calcium and magnesium salts upon particles of undigested food.

A teaspoonful or more of gritty sand may escape with each stool. But 4 cases of true enterolithiasis have been reported. The condition is likely to arise when the diet is exclusively milk. "Sand" may be produced through the ingestion of the banana (Myer and Cook).

INTESTINAL OBSTRUCTION

(*Ileus*)

Definition.—An acute or chronic, complete or partial, occlusion of the intestinal canal.

Pathology and Etiology.—The causes of intestinal obstruction may be divided, at once most simply and practically, into the (1) *acute* and (2) *chronic* forms. In the former variety the narrowing or closure develops very suddenly or rapidly, and usually in the small bowel; in the latter the large bowel is commonly affected by pathologic conditions that develop gradually and narrow its lumen (usually in advanced years).

Acute.—(a) *Strangulation.*—In the order of frequency, this is first among the causes of acute intestinal obstruction. It is produced most often by bands of adhesion the result of a former recent or remote peritonitis, and is most commonly situated in the right iliac fossa. Incarceration of the bowel from flexions and adhesions not rarely follows upon abdominal section for the treatment of pelvic disease in women.

The usually free end of Meckel's diverticulum is sometimes attached to the abdominal wall, and may thus cause constriction of a loop of bowel. This diverticulum is the remains of the fetal omphalomesenteric duct, and arises from the ileum about $\frac{1}{2}$ meter (1.64 ft.) from the ileocecal valve. A similar constricting band is formed by a cord representing one or more of the obliterated omphalomesenteric vessels. The adhesive attachment of the free end of the appendix vermiformis may also form an opening through which the bowel may be caught.

Internal strangulation (hernia) may be the result of forcing a portion of bowel through a slit in the omentum or mesentery, or into peritoneal diverticula and openings, such as the duodenojejunal fossa (*Treitz's retroperitoneal hernia*) or the foramen of Winslow.

Diaphragmatic herniæ are not of extreme rarity, and may be either of congenital or traumatic origin. Most cases of intestinal strangulation occur in males during early adult life.

(b) *Intussusception.*—*Invagination* is the descending "telescoping of one section of the bowel into another," probably caused by a circumscribed, irregular peristalsis of the intestine. The effect of the latter state in producing invagination may be either a thrusting forward of the receiving portion by a contraction of the longitudinal muscular coat (Nothnagel), or a thrusting inward and downward of the portion immediately above by means of an increased or spasmodic peristaltic action. Thus, a cylindric or sausage-shaped tumor results, varying from $\frac{1}{2}$ inch to over 1 foot (1.3–30 cm.) in length. The layers

met with in intussusception are the outer or receiving, called the *intussuscipiens*, the middle or returning layer, and the inner, called the *intussusceptum*. The seat of invagination is most commonly at the ileocecal valve, though it is often found in either the ileum or colon alone. Sometimes the intussusception is detected in the rectum. A lateral or partial invagination may also occur due to the attachment of a tumor within the bowel.

The intussuscepted portion of intestine is usually the seat of peritoneal adhesions, so that in pronounced cases the parts are so firmly agglutinated that reduction is wellnigh impossible. The engorgement may pass into an intense local inflammation, with final necrosis and sloughing, and even the discharge *per rectum* of the invaginated portion.

Intussusception occurs most frequently in children prior to ten years of age, and males suffer more than females. Invagination is an occasional consequence of the operation of circular enterorrhaphy (Robinson).

(c) *Volvulus*.—Twists of the intestine are met with most commonly at the sigmoid flexure of the colon. An unusually long or relaxed mesentery predisposes to the condition, so that the axis of twisting may either consist of the mesentery itself or frequently of the bowel. Not rarely the pedicle of the volvulus contains both a twist and a sharp bend in the bowel, causing complete acute strangulation. The latter condition may be pronounced in such cases, or at least be hastened, by the accumulation of the intestinal gas and of masses of feces—by bowel adhesions to an adjacent stump of omentum (Nieberding). The passive reactive pressure of the coils of intestine and of the abdominal walls tends also to further confine the enormously dilated and twisted loop of bowel to its abdominal state. Knots may be formed by the association of loops of the ileum with each other or about the pedicle of a twisted cecum.

Males between forty and sixty years are especially the subjects of volvulus. Acute intestinal obstruction invites bacterial invasion, which is the probable cause of the general symptoms.

Chronic.—(a) *Fecal Impaction*.—*Intestinal Concretions*.—Accumulation of feces (*coprostasis*) is a common cause of intestinal obstruction, the impaction taking place usually in the cecum or sigmoid flexure.

Though not infrequent in children, fecal obstruction is more common in adults (particularly in females), in the hysteric, the demented, and the hypochondriac. Congenital dilatation of the colon may predispose to coprostasis, and an acquired dilatation, which in some cases becomes enormous, is often the result of paresis of a portion of bowel caused by overdistention for a long period of time.

Among other causes of obstruction due to abnormal contents may be mentioned *enteroliths*. These are intestinal concretions formed of various nuclei, as gall-stones, hardened feces, phosphates of lime and magnesia, various foreign substances, and organic derivatives. Balls of tangled ascarides may mass sufficiently to cause obstruction.

Foreign bodies, as pins, buttons, coins, fruit-stones, may also cause obstruction of the bowel. It is stated that even insoluble mineral medicines, as bismuth or magnesia, have caused obstruction.

(b) *Tumors* cause a form of chronic obstruction that may at any time develop suddenly into the acute type. They may do so either as—(1) *new growths* in the wall of the intestine itself, or by (2) *compression and traction from without*. Again, the intestinal neoplasms may be *malignant* or *benign* in nature. *Carcinoma* of the bowel is at once the most frequent and important of these. It may be either circumscribed and annular, causing a gradual narrowing of the bowel lumen, or a diffused infiltration of the intestinal wall, commencing

either in the mucosa or in its glands (cylindric epithelioma). Its most common seat of growth is the large bowel, about the sigmoid flexure.

Sarcoma usually attacks the small bowel, starting beneath the mucosa, and is of the recurrent variety. Regional infection of the mesenteric and retroperitoneal glands (*Lobstein's cancer*) is also a usual consequence of sarcoma. It may occur in children or in young adults.

Benign tumors may be polypoid, adenomatous, fibromatous, and lipomatous. Intestinal obstruction due to compression or traction may be caused by tumors (omental) or by adhesions of the pelvic viscera.

(c) *Cicatricial strictures* cause chronic intestinal obstruction, as after the healing of various ulcers, the cicatrices of which slowly contract. Cicatricial stenosis of the colon is commonly due to the cicatrization of dysenteric ulcers. In the rectum the stenosis is usually a result of a syphilitic lesion. Tuberculous and, rarely, typhoid ulceration may be followed by stricture of the small intestine.

(d) *Congenital stricture* is rare, and is more purely surgical than the preceding cases. It is often an occlusion or an imperforate condition of the anus (*atresia ani*), and is only mentionable in this connection.

(e) *Paresis of Peristalsis*.—This condition—called also *adynamic obstruction*—while it is a functional affection, is held to be either a circumscribed or diffuse paresis of the intestinal muscular coat. It is caused by some such inflammatory disturbance as enteritis or peritonitis, or even by the manipulations employed in abdominal sections. Here the obstruction is due to an accumulation of feces and gases in the paretic portion of the bowel, causing tympanites, vomiting, and constipation.

Special Pathology.—The pathologic changes that accompany nearly every form of intestinal obstruction are briefly stated as follows: Accumulative dilatation—with hypertrophy in chronic cases—of the intestine above the seat of disorder, and an emptiness, narrowing, and even atrophy below the obstruction. The affected walls of the bowel are inflamed, and there is a surrounding acute or chronic peritonitis. Catarrhal and sometimes diphtheritic inflammation of the mucosa may develop. Gangrene, ulceration, and perforation of the bowel, with resulting generalized peritonitis, may also ensue.

Symptoms.—Acute Obstruction.—There is a suddenly developed *abdominal pain* that may follow some abrupt or severe exertion. *Early vomiting* and *absolute constipation* are also conspicuous and important symptoms. If the obstruction is high in the small bowel, distressing hiccup and eructations may precede the vomiting. Except for the possible discharge of the intestinal contents below the seat of obstruction, the constipation is usually complete and obstinate. The early symptoms, however, are caused by strangulation rather than by obstruction. Accompanying the latter condition there is tympanites, which is most marked in obstruction of the colon. Intermittent and colicky at first (partial obstruction—Treves), the *pain* soon becomes agonizing and constant. *Vomiting*, also, alternating with *painful retching*, is more constant and severe after several hours. The *material* at first ejected is gastric and mucous; it then becomes bilious, and finally is characteristically stercoraceous.

The *constitutional symptoms* develop early, are intensely threatening to life, and cause rapid and profound collapse. In general, the higher the obstruction in the intestinal tract, the more severe and the more acute are the constitutional symptoms. The pinched and pallid features, cool and moist skin, Hippocratic expression, rapid and feeble pulse, the usually subnormal temperature, shallow and accelerated breathing, marked thirst, scanty urine, great anxiety and prostration—all indicate the gravity of the condition. Cooke,

and in the large intestine. In the former vomiting occurs early, is scanty, and later feculent, while in the latter there is less vomiting and the vomitus is seldom feculent. Again, in obstruction of the small gut the distention is both less marked and higher situated, while in that of the large gut tympanites is often quite marked, is more central, is associated with tenesmus, and sometimes with mucus and blood. If the cause of obstruction be a tumor or stricture, the locality may be successfully palpated or the lower limit of the active coils of hypertrophied intestine may be defined.

Examination *per rectum* with the finger or with the rectal tube, by means of liquid distention or gaseous inflation of the colon, may enable us to determine the seat of obstruction in certain cases. The detection of a deeply seated incarcerated hernia (in the abdominal fossæ and pouches, diaphragm, or obturator foramen) is often made only *postmortem*.

Nature of the Obstruction.—This is even more difficult of discovery than the preceding. The following causes of obstruction with their differentiation may be referred to in attempting a diagnosis: *Strangulation* often affords a previous history of peritonitis or abdominal section or of recurrent attacks of abdominal pain, occurring mostly in young adults. Early fecaloid vomiting is common.

Intussusception usually gives a negative previous history. The suddenness of the attack, without appreciable cause, occurring in a child, and associated with colicky pain, tenesmus, and the presence of mucus and bloody stools, and of an elongated cylindric tumor in the right iliac or umbilical regions often render this condition easy of diagnosis. It is to be noted that absolute constipation and meteorism are here unusual. The intussusception may be felt in the rectum.

In *volvulus* it may be helpful to elicit a history of former constipation and flatulence, with evidences of atony of the bowel, in persons of advanced years, along with marked abdominal tympany, tenderness over a distended coil, which may perhaps be outlined (Wahl), a rigid abdomen, and sometimes dyspnea from great gaseous distention.

The history in cases of *fecal obstruction* is nearly always one of obstinate, habitual constipation, and occurs especially in females and neurotic subjects. The onset is gradual; pain is less acute; and tympany and fecal vomiting are less prominent and late in appearance.

Obstruction due to *large enteroliths* or *foreign bodies* may be only surmised; especially is this true when symptoms of appendicitis arise.

Biliary calculi may give a history of previous attacks of hepatic colic and of recurrent jaundice.

In the chronic obstructive form of *stricture* of the bowel due to cicatrices or neoplasmata the history of dysentery, tuberculosis, sarcoma, or carcinoma should be considered (*vide* Carcinoma intestinalis).

In obstruction caused by *intestinal paresis* there is generally a history of a previous enteritis, peritonitis, or celiotomy. The abdomen is smooth, though tympanitic throughout, and there is no perceptible peristalsis.

Not rarely it will be of therapeutic as well as of diagnostic importance to ascertain whether an attack of acute obstruction is primary, or whether it is the terminal exacerbation of a chronic condition, such as carcinoma of the bowel. Here a study of the past history of the patient, as well of the present signs of a probable nature, will afford considerable aid.

Differential Diagnosis.—Acute intestinal obstruction must be discriminated from *acute generalized peritonitis*.

moved, as in many cases there are both paresis and inflammation at the seat of impaction, so that this class of agents would in most cases at least be useless, if not harmful. High rectal injection, copious, steady, and regularly repeated, are to be practised, using for this purpose preferably "warm saline solution of olive oil" (particularly if scybala be present) administered while the patient is in an inverted position by means of a fountain syringe, so that the flow is readily controllable. The abdomen should be methodically kneaded and the patient at times well shaken. This method of treatment, by hydrostatic pressure, can and must be carried forward without undue violence, and if it be unsuccessful, the intestines are to be inflated from a large india-rubber bag with air or hydrogen gas (Senn), of which 2 to 3 gallons may be cautiously introduced. Thorough manipulation of the abdomen from below upward, particularly if it be a case of intussusception, may be combined. In the latter condition inflation, early and perseveringly applied, cures the majority of instances. If not promptly relieved, immediate operation is to be encouraged and advised. Although the statistics of Fitz show the mortality in cases without operation to be lower (69 per cent.) than with operation (83 per cent.), I am convinced from personal observation that the less favorable results from abdominal section would not obtain if it were performed in due time.

In chronic obstruction the treatment of the underlying or etiologic conditions and various complications is to be conducted on general principles. Additionally, the patient's dietary is to be arranged with care, and the bowels moved with unfailing regularity, by the use of unirritating laxatives and enemata. If total obstruction persist despite medical treatment, surgical treatment—enterectomy, enterotomy, or other operation, as the circumstances of individual cases may dictate—is required.

The after-treatment consists in keeping the bowels active and regular by habit, diet, and an aperient pill if needed. Massage and electricity to the abdomen are found useful at this time.

Stenosis of the Duodenum.—Duodenal stenosis invariably develops secondarily upon morbid processes either in the duodenum or adjacent organs. Extensive studies of the subject have been made by Leichtenstern, Perry and Shaw, Wilms, Boas, Laffer, and others. The *causes* are principally intraduodenal ulcer of the duodenum (53.44 per cent.), carcinoma of the duodenum, sphincteric action of the muscular layer of duodenum, and gall-stones. Among extra-duodenal factors are "diseases of the pancreas, compression by the root of the mesentery, adhesions, morbid growths, kinking, and gall-stones" (J. M. Anders¹). *Symptoms.*—When the stenosis is suprapapillary or at the ampulla of Vater, marked dilatation of the stomach and of the duodenum above the stenosis usually occurs. When at the ampulla, obstruction may show acholic stools containing enormous numbers of fatty acid crystals, and jaundice. Neither blood nor bile are found in the vomitus as a rule. Stenosis below the ampulla of Vater is characterized by absence of meteorism, biliary, but never fecal, vomiting, the temporary disappearance of meteorism in the epigastrium after vomiting and early anuria. Stenosis due to kinking causes sudden severe pain, frequent vomiting, and decided shock. The *prognosis* is dependent on the special cause, while the *treatment* is appropriately surgical.

¹ *Amer. Jour. Med. Sci.*, 1912, cliv, 360.

sarcomata, fibromata, myomata, adenomata, and cystomata may produce symptoms of obstruction like those due to carcinomatous growths. The cancerous cachexia may be simulated by other conditions. The advanced age of the patient and the rapid and downward progress of the disease will, however, point toward malignancy. *Enteroliths, foreign bodies, and old peritonitic adhesions* may need to be excluded also. Fecal masses may exist above and overshadow the presence of carcinoma.

(b) *The portion of the bowel involved* by the neoplastic growth is also difficult of definite diagnosis. The locality of the tumor as detected by palpation, associated with special symptoms, is of value in arriving at a diagnosis of the diseased portion of the bowel. Heulin has studied carefully primary cancer of the duodenum, and asserts that the comparative frequency of duodenal involvement is due to limited motion of the organ, being thus subject to injury. When it occurs above the papilla of Vater the symptoms greatly resemble those of *dilatation of the stomach*. An important point separating carcinoma above from that below the papilla is the presence or absence of bile in the vomit, being absent if situated above. When the carcinoma involves the papilla of Vater symptoms of biliary obstruction necessarily follow. A hard, nodular mass may sometimes be felt in the lower epigastric region; this coupled with increasing gastric dilatation and marked persistent jaundice would indicate carcinoma of the duodenum. It is apparent, however, that *carcinoma of the pylorus*, of the left lobe of the liver, or of the omentum or mesenteric glands, or a thickened cecum might all be easily confounded with carcinoma of the bowel at various adjacent parts of its course. The injection of fluid into the bowel may be resorted to in locating the probable situation of the growth. Thus, if obstruction from carcinoma exists in the sigmoid flexure, liquid will be arrested there and the rectum distended; while, if the stenosis be high up in the large or small intestine, the colon will be found comparatively emptied of feces and will be distended with the injected liquid. Carcinoma of the appendix usually gives rise to the symptoms of appendicitis with slight fever. These cases generally occur between the ages of twenty and thirty years (Kernhadjian).

Course and Complications.—Carcinoma of the intestine sometimes runs a rapid course, and may last but a few months; in the scirrhus variety, however, the disease may last two or three years.

Intestinal carcinoma may perforate the bowel and cause fatal purulent peritonitis. Or, owing to extreme distention by fecal accumulation between a cancerous stricture of the sigmoid flexure, for instance, and the resistant ileocecal valve, rupture of the colon, followed by peritonitis, may result. Extension of the growth into surrounding tissues, with ulceration, may lead to cellulitis, phlebitis, and pyemia; and extension from the rectum may cause purulent vaginitis and cystitis.

The **prognosis** is almost hopeless.

Treatment.—This, from a strictly medical standpoint, is simply palliative. The diet should be highly nourishing and easily assimilable, but when the symptoms of acute obstruction supervene the administration of food by the mouth is contraindicated. Opium or cannabis indica for the pain, and stimulants for the depression, may also be serviceable.

Lavage of the stomach gives decided relief for regurgitation on account of the damming back of accumulated food detritus.

Carcinoma of the bowel may be treated surgically by colotomy, excision, lateral anastomosis of the bowel, enterostomy, and, if the growth be situated in the rectum, by extirpation by means of sacral resection (*Kraske's operation*). Operability does not necessarily depend upon the duration of the disease.

colon, with coprostasis (as in Formad's case). (f) Tonic contraction of the muscular coat, as in basilar meningitis and lead-poisoning, or due to spasm of the intestine from some reflex cause (spastic constipation). (g) Enteroptosis; notably cecum mobile associated with ptosis of the ascending colon. (h) Retention of the gastric contents. (i) Clinical evidence of stasis in the terminal ileum is almost always associated with ileocecal valve incompetency (Case). (j) Antiperistalsis (anastalsis) is held by some observers to be responsible for failure of the fecal mass to leave certain portions of the intestines with normal rapidity. (k) Dyschezia, or incomplete emptying of the rectum, is present in about 60 per cent. of cases of chronic constipation. It may be caused by any of the general causes of constipation, as a result of which the rectum has lost its normal expulsive power. (l) Keith holds that mechanical factors play but little part in the production of stasis. He considers the intestinal canal as consisting of four zones, each with its own pace-maker and rhythmicity. These various zones must co-ordinate one with another in order to have the food propelled along in a normal manner. Blocking of the impulses from a pace-maker as a result of disease produces not only inefficiency of the intestinal musculature of the affected zone but also of the other zones.

Symptoms.—In cases in which there is no adequate cause for habitual constipation other than a constitutional or inherent peculiarity there may be the true appearance of perfect health. Nothing is complained of save the fact that an evacuation of the bowels occurs too infrequently. The term "constipation" is, individually speaking, almost wholly a relative one—*i. e.*, one person may enjoy good health with but one evacuation every other day, another with two passages per diem, while still another must have one stool a day, *cæteris paribus*, to feel perfectly well. The last is usually considered an average normal state with most people.

Symptoms of habitual constipation may be direct or reflex. *Direct* or *local* troubles are seen in the feeling of fulness, weight, and pressure in the perineum and abdomen. Flatulence, colicky pains, and alternating diarrhea occur not infrequently. The hurried and inattentive performance of defecation gives rise to the so-called "cumulative constipation," in which the accumulated feces are but partially evacuated with the movement, and the rectum consequently is not emptied. A sense of fulness then remains, and complete relief is not felt in these cases.

Reflex and *general* symptoms are malaise, languor, hebetude, irritability of temper, headache, facial flushing, palpitation, cold extremities, anorexia, vertiginous attacks, paresthesia, menstrual distress in women, sleeplessness, and bad dreams. Pressure on the sacral and visceral nerves may cause neuralgias. The tongue is coated. Palpation of the abdomen often shows the presence of doughy-like fecal tumors at the cecum or at the hepatic, splenic, and sigmoid flexures, or of bologna-like masses at intervening places. In marked cases attacks of nausea and vomiting, with diarrhea, may ensue; fever may also be present.

Complications and Sequelæ.—Hemorrhoids, ulcerative colitis, perforation, and enteritis may be associated with chronic constipation. Not rarely we have as results dilatation of colon or sacculations, with the presence, in old people mainly, of *enteroliths* (calcified scybala); intestinal obstruction and typhlitis, or cerebral hemorrhage or hernia from violent straining efforts.

Diagnosis.—Bearing in mind the relativity of constipation in different individuals, the diagnosis is read at sight. The detection of the causes is not difficult, though sometimes tedious. An etiologic diagnosis may require modern methods, such as a roentgen-ray examination, the examination of the feces according to Schmidt, and the procedure known as rectoromanoscopy.

is neither absorbed nor toxic in the least. The dose is from 1 to 2 ounces once or twice daily on an empty stomach. Its use should be associated with other adjuvants to correct chronic constipation, *e. g.*, exercise, regular hour for stool, and diet. In the chronic constipation of the aged, the bedridden, or of the multiparous woman whose intestinal walls are too relaxed to be of any service in overcoming the constipation, the fluidextract of cascara is probably the best remedy. Its dosage can be controlled so that an amount necessary to produce a daily stool can be administered without inconvenience. Furthermore, it is not habit-forming in the sense that the intestinal musculature becomes used to it and increasing doses are unnecessary.

The **mechanical** means of relieving habitual constipation, as by *enemata*, are injurious if long continued, by reason of their irritating effect on the rectal and colonic mucous membrane. At times when the stomach is weak or irritable, a loaded bowel may be relieved by an ordinary enema of soap and water or by one containing $\frac{1}{2}$ to 1 ounce (16.0–32.0) of castor oil, with 1 or 2 drams (4.0–8.0) of oil of turpentine if there be some flatulence. Glycerin enemata, containing from $\frac{1}{2}$ to 2 ounces (16.0–64.0) of the agent, may be used. Fleiner has suggested oil injections. From 2 to 4 ounces of sweet oil warmed to body heat by standing the containing bottle in a vessel of hot water, may be injected slowly through a piston-syringe on retiring and retained until next morning. Riesman, who has had a considerable experience of their use, speaks strongly in favor of oil injections. *Suppositories* of soap, molasses candy, or glycerin are included in the armamentarium. *Massage* also claims an important part in the relief of habitual constipation. It acts by stimulating the peristalsis and the abdominal muscles, and should be employed at set times in the day preceding a desired evacuation of the bowels. The hand of the *masseur*, or that of the trained patient even, when systematically used in this way, may be effectual when all other means have failed. In constipation in the aged male Hollis recommends pressing the gerontal right index-finger on the perineum just behind the symphysis to relieve the pressure of an enlarged prostate on the rectum during defecation. The regular rolling of a metal ball along the course of the greater gut may be mentioned for its novelty as well as for its undoubted efficacy. The application of the faradic current to the abdominal walls or galvanization of the lumbo-abdominal circuit deserves proper trial in many cases. Hydrotherapeutic measures or cold sponging and baths are nearly always useful adjuncts.

INTESTINAL TOXEMIA

This condition is closely associated with constipation, and, as a rule, is responsible for the symptoms, at least for the systemic manifestations, that arise in this disorder. Although not a pathologic entity, it is readily recognized clinically and is supposedly due to the absorption into the circulation of toxic bodies which are formed during intestinal digestion. Such toxic bodies may arise from injuries to the mucous membrane; they may be produced by the bacteria that normally inhabit the intestines, though soluble toxins are, in all probability, not formed by the normal flora of the intestines; they may be elaborated by decomposition of food-stuffs with production of toxic substances which may be subsequently absorbed. This latter cause is probably the one that operates in the majority of cases. Thus it has been shown that, during the process of digestion of proteins, the amino-acids that are formed are capable of producing exceedingly toxic substances, possibly with bacterial as-

headaches. Autogenous colon vaccines in doubtful cases are an aid to differential diagnosis (Barnes).

Treatment.—In the *acute form* the treatment of the cause suffices as a rule. Purgation by means of mercurials followed by a saline are indicated first of all. The *diet* must be fluid and much restricted in amount, milk and gruels being especially serviceable. Water is to be taken freely, if retained. In the *chronic form* digestible solids, composed principally of vegetables, milk (particularly sour milk), bread, and cereals should form the protein in the diet. These, with fruits, bacon, and butter, in right proportions, will give 65 grams of protein daily. Recent experience justifies the belief that in the fermentative cases the carbohydrates (sugar, starch) must be much restricted, *e. g.*, dry toast or stale bread. Laxative articles of food and such as leave a maximum residue in the intestines are efficacious in overcoming constipation. The use of two or three glasses of cold water or mineral water on retiring, on rising, and between meals favors elimination, both through the bowels and kidneys.

The function of the latter is of the highest importance as a channel of elimination. If the above suggestions do not afford thorough relief daily to the bowels, warm saline laxatives before the morning meal are to be advised. Among the most efficient are sodium phosphate and sodium sulphate, or the aperient waters, as Hunyadi, Apenta, Carlsbad, Veronica, and the like. It may be necessary to administer a mercurial from time to time to maintain biliary secretion. Gastric lavage and colonic irrigation should be resorted to in the acute gastro-intestinal attacks. The mouth condition and gastric features must be treated as recommended in appropriate sections of this work. Cutaneous elimination is to be aided by hot baths or Turkish or Russian baths; they must be carefully adapted to the individual cases. Physical exercise deserves proper trial in most cases and massage is also a useful adjunct when active exercise is unsuitable.

For the flatulence which often proves annoying, intestinal antiseptics are indicated. Of some value for this purpose are beta-naphthol, phenyl salicylate, and menthol. These remedies should be administered as suggested by Forchheimer, namely, in the form of an intestinal pill or one dissolved only in an alkaline medium, and Waldstein recommends a coating with an alcoholic solution of shellac containing salol to accomplish this object. Kaolin in large doses, 4.0 to 8.0 grams, three times a day after meals, makes an efficient intestinal antiseptic, depending not upon its antiseptic properties but upon its mechanical action, the bacteria adhering to the minute particles of the clay and being carried along with the fecal stream. It has been suggested to raise the content of *Bacillus coli communis* in the bowel "by instillation either of the autogenous mixed forms or strains from other individuals" (Bassler). Satterlee advises vaccine therapy in the treatment of this condition, as follows: "(1) Mild chronic toxemias which do not respond to diet; (2) all severe chronic toxemias; (3) operative cases (a) before and (b) after operation." The underlying and etiologic conditions and complications must receive due attention in every case.

DILATATION OF THE COLON

(Ectasia of the Colon)

This is usually a chronic condition, though not rarely it is acute. It may also be general, but in the majority of cases it is confined to the colon, and particularly to the sigmoid flexure. The *postmortem* findings are those of hypertrophic dilatation of the bowel, and rarely ulcerative and catarrhal lesions of the intestinal mucosa are noted. The sigmoid flexure is prone to become dilated in subjects in whom it is congenitally elongated. Atony of the muscular coat is a leading causative element. The most distinctive features are *constipation*, which generally dates from infancy, and *great abdominal distention*. Peristaltic waves may be visible upon the surface. The condition may exhibit constipation alternating with regular daily movements, and the distention changing to a normal softness of the abdominal parietes. I have recently seen a case of this kind in a male aged twenty-seven. In the *treatment* of the constipation, lavage of the intestine with a very long tube is superior to laxatives or purgatives. A *diet* calculated to prevent or relieve constipation is indicated. Vegetable foods leaving a gross residue should be prohibited. Massage, galvanism, and hydrotherapy are all capable of beneficial effects in suitable cases. Strychnin is a valuable remedy, as is also beta-naphthol for its antifermentative action, and in cases attended with constriction surgical measures should be considered.

NEUROSES OF THE INTESTINE

As in the case of the stomach, these embrace derangements of (a) secretion, (b) sensation, and (c) motion.

(a) SECRETORY DISTURBANCES

Unquestionably the intestinal secretion may, through a purely nervous influence, be augmented. This manifests itself most frequently in the primary morbid secretion of mucus (*mucous colic*) and in membranous enteritis. Moreover, the fact that an actual catarrh of the intestinal mucosa may supervene as a secondary event is undeniable.

MUCOUS COLIC

(Colitis Colica; Enteritis Membranacea)

Definition.—A peculiar pathologic condition, chiefly of the large intestine, attended by a morbid secretion of mucus.

Pathology.—In the truly primary form there are no morbid lesions discoverable in the mucosa. From mucous colic we must distinguish membranous enteritis, which is associated with an inflammatory process of the mucosa accompanies typhoid fever, dysentery, and many other affections. This is a catarrh of the colon, while true mucous colic, the disease under consideration, is a functional (secretory) disturbance.

Etiology.—Sex has a decided influence, 80 per cent. of cases are observed in neurotic women. It is rare in children. Direct mechanical irritation of the rectum (horseback-riding, bicycle-riding, hardened scybala, etc.). Bacteria are believed to play a causative rôle, particularly the *Bacillus coli communis*. By many it is held to be a manifestation of abnormal vagus irritability.

Symptoms.—I have found the condition associated with a constipated habit—a fact that may, in part, explain its occurrence, since time is thus allowed for cast-formation. The important feature is the *passage*, at *varying intervals*, of *long, ribbon-like threads of mucus*, or of more or less *perfect casts of the gut*, with *tenesmus* and severe *colicky pains*. The stools consist of a turbid ground substance, which, on the addition of acetic acid, becomes opaque and striped; cellular detritus, consisting partly of granules and partly of cellular elements, including blood. Symptoms of neurasthenia are present and are often quite pronounced.

The individual paroxysms vary in *duration* from one to ten days or more. In one case observed by me the attacks lasted about two days, recurring regularly at the end of every three months. Ordinarily the recurrence is after a shorter interval.

Diagnosis.—A microscopic examination of the pieces of membrane insures the diagnosis. It is to be recollected, however, that membranes are not passed with every attack, and that there is a complete absence of the signs of organic disease between the attacks of colic.

Course and Prognosis.—The disease pursues a very chronic course and lasts for many years. The bodily nutrition suffers considerably if the attacks are frequent and severe, but, as a rule, this does not occur until a late stage in the affection. The risk to life is slight.

(b) SENSORY DISTURBANCES

It may be noted here that the sensory nerves of the intestines, as well as the inhibitory and vasomotor dilators, are traceable to the splanchnics. Increased sensibility of the sensory nerves produces—

ENTERALGIA

(Neuralgia of the Intestine)

Etiology.—This is commonly met with in hysteric, neurasthenic, and anemic subjects. It occurs as a reflex neurosis, as in the case of cold, gout, and irritative lesions of the pelvic organs (kidneys, liver). Enteralgia is symptomatic of many local affections and conditions that induce direct irritation of the sensory nerve-filaments of the intestine; among these are inflammation of the mucosa, foreign bodies, gall-stones, abnormal distention with gas, and enteroliths. Under these circumstances the condition is associated with increased activity of the motor nerves or heightened contraction of the muscularis, forming true intestinal colic. In lead-colic it is probable that the lead acts directly upon the nerves or their ganglionic cells. I have repeatedly observed the action of certain exciting causes (*e. g.*, nervous shocks).

Symptoms.—Enteralgia may develop very *suddenly*, but oftener it sets in less abruptly, and is then attended with eructations of gas, expulsion of flatus, and the like. In the fully developed attack the *pain* may attain great violence, causing the patient to “bend double” or even faint, and its character is variously described as boring, tearing, or cutting. The pain may be confined to a circumscribed spot or may be diffuse. The attacks are sometimes brief, or they may be characterized by a sudden subsidence. At other times they last for days or perhaps weeks, and then subside gradually. Recurrences are common.

Hypogastric neuralgia is a term applied to neuralgia affecting the sensory nerves lying in the most dependent segments of the intestine. Here the nerve-fibers entering into the hemorrhoidal plexus are involved. It is caused chiefly

ENTEROSPASM

(Spasm of the Intestine)

This term is meant a concurrent spasm of both the longitudinal and muscular fibers, usually inducing spasmodic constipation, and sometimes, though temporary, occlusion of the bowel.

Causes are similar to those of nervous diarrhea, and the condition is related to enteralgia. Neither pain nor constipation, however, is an essential feature. The stools may assume the form of a ribbon or of large masses (sheep's dung), but they are not pathognomonic. They may be covered with mucus. Ewald distinguishes between an idiopathic and primary or symptomatic spasm, the latter being a concomitant of basilaris and of chronic lead-poisoning (see also Constipation, p. 844).

A variety affects the rectum (*proctospasm*), and is generally secondary to other rectal affection, as fissure of the anus; it may, however, occur as is in the hysteric and nervous class of subjects.

Diagnosis of true functional enterospasm can only be made after all causes that may produce spasm of the bowel have been excluded.

CONSTIPATION

is a common condition as a neurosis. It is due to an abnormality of the intestinal nerves that leads to a weakened peristaltic action, met in hysteria, neurasthenia, and the various forms of psychoses. nervous affections often manifest atony of the intestine as a symptom; its form is not a disease *sui generis*. Cases of this class do not respond to variety of cathartics (Ewald).

Relaxation of the external sphincters is a common concomitant in a great number of local (catarrhal) and central nervous diseases. Under these circumstances the act of defecation may be purely *reflex*, owing to loss of control of voluntary muscles; or it may be *voluntary*, except when the person affected is on his guard, or during mental excitement, micturition, sneezing, and shudders.

Treatment of Intestinal Neuroses.—A suitable change of environment, including an appropriate arrangement of the dietary, is of primary importance, and is uniformly applicable in this class of sufferers. Further, treatment of special cases has peculiar reference to the character of the derangement. After making an accurate diagnosis a search for the cause of the greatest etiologic importance should be made, and these must be vigorously assailed.

In the *secretory neuroses* an associated mucous colic must be corrected, attention is to be improved if faulty, and the obstinate constipation overcome. For the latter symptom enemata containing ox-gall, either alone or in combination with salines, are especially serviceable. Kussmaul and Fleiner obtained the best results from regular large oil-enemata administered twice daily. During the painful attacks copious enemata of normal saline solution to which has been added oil of peppermint (5 drops to the pint at a temperature of 100° F.) will sometimes bring speedy relief from the pain and distressing colonic symptoms, and will assist nature's efforts at clearing the cast-formations. Pain must be at times relieved by morphine. Results of treatment of mucous colic, however, are unsatisfactory. Surgeries have been adopted in selected cases.

In the *sensory disturbances* in which the activity of the sensory nerves is increased (enteralgia and hypogastric neuralgia) the treatment may be divided under two headings: first the relief of the neuralgic pains; and second the correction of the causes or conditions on which the enteralgia

depends. If the pain be severe, opium or morphin may be required. Especially good as an antispasmodic is codein, which may suffice in all save the severer cases. The object should be to give the minimum amount of the opiate that will meet the necessities of the case, with a view to obviating a resultant constipation. In hypogastric neuralgia I have found suppositories containing opium to be little short of magical in their effects.

In cases in which there is constipation due to diminished sensibility, with a loss of motor innervation (atony of the bowel), the feces must be artificially removed unless the underlying condition can be successfully overcome. It is especially important that the environment—physical and psychic—be so regulated as to bring about an improvement in the general condition of the patient. It may become necessary to employ tonic preparations of strychnin, iron, or arsenic.

The treatment of nervous diarrhea involves the same principles, so far as the indication presented by the peculiar nervous organization is concerned, as in the sensory and secretory neuroses. It is especially important to prevent the operation of the direct causes—fright, mental excitement. Astringents and intestinal antiseptics are not called for unless the bodily nutrition be affected thereby. Enterospasm is to be met by the same remedies that are used to control enteralgia.

IX. DISEASES OF THE LIVER

ANOMALIES IN SHAPE AND POSITION

Altered Shape.—**Malformations** of the liver may be either the result of disease or of pressure of adjacent structures. The former “may be due to syphilis, fetal peritonitis, or possibly to tuberculosis” (Rolleston). Of the latter class the most important cause is tight lacing, met with almost exclusively in women and producing the so-called “corset-liver.” The lower part of the right lobe of the liver is usually the part affected; the hepatic parenchyma is atrophied owing to continued compression, and shows deep grooves that correspond to the position of the lower ribs. The connective-tissue capsule and the peritoneal coat are both thickened at this point. In marked cases the right lower lobe may become converted into a dense fibrous band. Among other acquired causes of anomalies in shape may be mentioned deformities of the vertebræ and ribs, or tumors of the ribs or adjacent structures (pylorus) pressing against the liver. Moser invites attention to multiple lobulation, as many as 16 lobules having been found; this is due to pathologic causes and is not a morphologic phenomenon.

Diagnosis.—Rarely, clinical symptoms are present. “A constant *sensation of pressure and pulling* is felt in the hepatic region, and sometimes, as a result of venous stasis, there is a temporary but decided swelling of the isolated portion, and, possibly, *violent pain* and indications of irritation of the peritoneum, such as *vomiting* and an approach to *collapse*. Jaundice is rare in consequence of this deformity” (Strümpell.) The danger of this condition lies in possibly mistaking it for an *abdominal tumor* (Pepper), *amyloid disease*, *passive congestion*, or *new growths* of the organ (Strümpell).

Primary alterations in the shape of the organ may be due to congestion, hereditary syphilis, hypertrophic or atrophic cirrhosis, acute yellow atrophy, carcinoma, abscess, or hydatid cyst. The accompanying *symptoms* would be those of the special disease causing the deformity.

Anomalies of position are not infrequently met with, the organ being displaced upward, downward, or laterally. The most common cause of

lateral displacement is an abnormal lengthening of the suspensory ligament. **The organ** may occupy the epigastric region or be displaced into the lower part of the abdominal cavity, but a change in the posture of the patient or external pressure is often sufficient to replace the organ. The *symptoms* (if present at all) consist of a dragging sensation, often amounting to pain and referred to the right shoulder. On *physical examination* palpation may reveal a fissure between the right and left lobes, together with a movable tumor presenting the size and normal outlines of the liver, which by manipulation may be repositioned. Percussion gives tympany over the normal hepatic area, which changes to flatness when the organ is pressed, or falls into its natural position.

Displacement upward may result from gastric or intestinal distention, marked ascites, or an abdominal tumor; while downward displacement may be due to a mediastinal tumor, emphysema, or a pleural effusion.

Diagnosis.—Among the conditions likely to be confounded with movable liver may be mentioned *carcinoma of the omentum* or of the *pylorus*, *dermoid cysts*, *tumors of the ovary and uterus*, *hydro- or pyonephrosis*, *tumors of the kidney*, and *chronic proliferative peritonitis*. By a careful study of the symptomatology, and in the absence of the normal physical signs over the hepatic area, the diagnosis can usually be established, although marked fatty degeneration or atrophic cirrhosis may coexist with any of the above conditions and cause marked diminution in the area of hepatic dulness. Steele's careful studies of 100 cases of floating liver show that colicky pains, often accompanied by jaundice and simulating *hepatic colic*, occur in nearly 40 per cent. of the cases.

The **treatment** of movable liver is merely palliative, and consists in the application of a suitable bandage for preventing the displacement.

JAUNDICE

(*Icterus*)

Definition.—A condition in which the tissues and secretions are stained with bile-pigments. Jaundice is not a disease, but a symptom.

Hepatogenous or *obstructive jaundice* is more commonly seen in: (1) **Inflammatory swelling** of the duodenum or of the lining membrane of the duct, which is by far the most common factor in its causation, and demands separate consideration (*vide infra*, Catarrhal Jaundice). (2) **Foreign bodies** within the ducts, as gall-stones or parasites. (3) **Stricture or obliteration** of the duct. (4) **Tumors** within the duct or obstructing its orifice. (5) **Pressure on the duct from without**, as by a tumor of the liver, stomach, pancreas, or omentum; also by fecal accumulations, displaced organs (*e. g.*, floating kidney), a pregnant uterus, enlarged glands in the fissure of the liver, and, more rarely, by abdominal aneurysm. (6) **Lowered blood-pressure** in the vessels of the liver favoring resorption of bile, as in simple icterus of the newborn (Frerichs).

Toxic (hematogenous) jaundice, so-called, has usually for its lesion extensive catarrh of the intrahepatic bile-ducts from their origin. Here duodenal catarrh is not necessary for the production of jaundice. It was formerly assumed that the pigment (hemoglobin) was liberated in the blood; but Stadelmann and others have shown that the bile containing the poison, or its irritant products (toxins), excite inflammation of the finer ducts. However, Whipple has been able to produce jaundice with the liver cut off from the circulation by introducing laked blood into extrahepatic circulation. While in various hemolytic anemias, notably the so-called chronic hemolytic anemia, jaundice is apparently produced by increased blood destruction without

lesions of the liver and bile-passages other than those produced by the increased hemolysis.

CATARRHAL JAUNDICE

(*Hepatogenous Jaundice; Icterus Catarrhalis; Duodenocholangitis; Inflammation of the Common Bile-duct*)

Definition.—A condition characterized by a discoloration of the tissues from retention and absorption of bile, and resulting from a catarrhal inflammation of the mucosa of the ducts and of the duodenum.

Pathology.—On examining a liver and gall-bladder *in situ* the former is usually found enlarged, lighter in color than normally, and of a distinct icteroid tint. On making a longitudinal section, drops of bile can be collected on the edge of the section-knife.

The gall-bladder is found distended with bile, and on firm pressure a tough plug of mucus is usually expelled from the common duct into the duodenum, after which bile flows into the intestine freely. The mucosa lining the *ductus communis* is swollen and inflamed, and the catarrhal process may extend to the cystic, and in some cases to the hepatic, duct. As a rule, that portion of the common duct lying in the intestinal wall is more frequently and more deeply involved. If the disease becomes chronic, a formation of connective tissue occurs owing to the irritation caused by the retained secretion, and atrophy of the liver cells, with biliary cirrhosis, may result. Suppuration is rare.

Etiology.—Simple catarrhal jaundice results in the majority of cases from extension of inflammation in gastroduodenal catarrh, though it may be a primary mildly contagious disorder, and the principal *predisposing causes* are as follows: (a) Exposure to cold and wet; (b) the use of improper foods, including faulty cooking and improper mastication; (c) the excessive or prolonged use of irritants (tea, coffee, alcohol); (d) prolonged anxiety and mental or physical overwork; (e) certain acute diseases, as pneumonia, relapsing fever, streptococcic septicemia, typhoid fever, and malaria (toxic jaundice, *vide supra*); (f) certain types of anemia associated with increased blood destruction, paroxysmal hemoglobinuria, black-water fever, the injection of hemolytic substances (*e. g.*, toluylendiamin) are examples of acute hemolysis associated with jaundice the result of simultaneous destruction of the red cells and changes in the bile capillaries; (g) portal obstruction, occurring in chronic heart or kidney disease; (h) it has occurred in epidemic form (V. Weil's disease). Barker and Sladen found that food (probably meat) was the most likely source of the infectious agent in an epidemic.

Symptoms.—Preceding the development of the distinctive features by several days, dyspeptic symptoms are in evidence (*vide* Gastrohepatic Symptoms). The symptoms of jaundice are, in general, those of the causative condition rather than the result of the deposition of bile-salts in the tissue *per se*. The principal symptoms in detail are: (a) *Icterus*, or tinting of the body surface, may be the first symptom noticed in this condition, appearing usually on the forehead and neck and rapidly spreading over the entire body. The conjunctivæ also early become discolored, and the general hue, though variable, is commonly a bright lemon yellow. In chronic cases the color is apt to change to a bronzed or deep green tint.

(b) *Secretions and Excretions.*—The urine and sweat are often found to contain bile-pigment, the patient's linen frequently being discolored. In extreme cases the urine may be dark green in color, while in those of average severity it is of a lighter or deeper greenish-yellow hue. The shaken specimen foams, and the froth has a yellow color tint. Often the presence of bile is detected before any noticeable coloring of the conjunctivæ occurs. In cases of intense

or long-standing jaundice albumin and tube-casts may be present, and the latter may be bile stained.¹ Hylaine casts are often found.

The bowels are constipated, and the stools are pale drab or slate colored; they are usually very fetid. Diarrhea, however, may be present owing to the production of irritating substances and decomposition.

The tears, saliva, and milk are rarely stained with bile-pigment. The expectoration also is rarely tinted unless pneumonia or some form of pulmonary infiltration coexists.

(c) *Circulation*.—The pulse, although not appreciably altered in volume or tension, is usually slow (often 30 or even 20 beats per minute), though this is not an unfavorable symptom. Windle found a pulse-rate of 40 and below in some cases, but in these the heart-rate was double that of the pulse. He questions whether the jaundice is responsible for either the infrequency or irregularity. Stewart and King have shown that this is due to stimulation of the vagus by the bile-salts.

(d) The *temperature* is usually normal, although slight elevations may occur (100° to 101° F.—37.7°–38.3° C.).

(e) *Gastrohepatic Symptoms*.—Dyspeptic symptoms—viz. anorexia, a sense of fulness after eating with flatulence, acid eructations, nausea and vomiting, accompanied by a dull, heavy pain over the hepatic area, with some tenderness on pressure—are present. These often develop insidiously; rarely they occur suddenly with a severe rigor or chill, violent headache, and vomiting—*e. g.*, at the onset in the epidemic form.

(f) *Cutaneous Phenomena*.—Pruritus or itching often becomes a troublesome symptom, being more common, however, in the chronic forms. Lichen, urticaria, furuncles, and sweatings (diffused and localized) may develop, the latter being often limited to the skin covering the abdomen and the palms of the hands.

A peculiar disease of the skin called *xanthelasma* or *bita higoidea* may also occur. It consists of bright yellow spots, slightly elevated, appearing on the eyelids, and rarely on other parts of the body.

In the severer forms ecchymoses and sometimes profuse hemorrhages may occur into the skin and mucous membranes. These are usually associated with symptoms of a grave type and are indications of increased blood destruction. In chronic obstructive forms the coagulation time of the blood is much delayed.

(g) *Nervous Symptoms*.—Headache and vertigo are common; irritability of temper, despondency, and wakefulness or mental dulness almost equally so. With the oncoming of darkness vision may grow indistinct (*hemeralopia*) or it may attain unnatural clearness (*nyctalopia*). Rarely, objects look yellow (*xanthopsia*). The nervous phenomena observed in catarrhal jaundice are attributable to the effects of the bile-acids. In certain cases, however, associated with destruction of the hepatic substance, as in acute yellow atrophy, carcinoma, cirrhosis, and fatty degeneration, grave cerebral symptoms (acute delirium, convulsions, and coma) may develop suddenly and prove fatal. This class of symptoms has been named *acholia*, *cholemia*, or *cholesteremia* (the latter owing to the mistaken supposition that cholesterin is the poisonous product). The true nature of the toxic agent in the blood is unknown. In some fatal terminations of this character death was due directly to renal complication.

¹ *Tests for Bile*.—*Gmelin's test*, or the play of colors, consists in bringing a few drops of urine in contact with the same quantity of commercial nitric acid on a plain white slab, whereupon various shades of yellow, green, red, and violet are produced.

Rosenbach's test is made by filtering the suspected urine and touching the filter-paper with a drop of nitric acid. If bile be present a green circle will form at the point of contact. (See also Choloria.)

The **physical signs** in a case of simple catarrhal jaundice show on palpation and percussion an increase in the hepatic area, the lower border of the liver projecting in some instances several fingerbreadths below the ribs. Rarely, the distended gall-bladder projects below the lower lobe of the liver, as when there is complete obstruction near or at the duodenum, and then it can be distinctly palpated.

Diagnosis.—The etiology, a history of previously existing gastro-intestinal catarrh, the age of the patient (young adult life), and the appearance of the jaundice unaccompanied by pain or general emaciation, together with an absence of symptoms pointing to *cirrhosis*, *carcinoma*, or *acute yellow atrophy*, form a characteristic grouping of clinical indications. Examination of the bile removed by the duodenal tube sometimes gives distinct diagnostic aid. Lyon¹ allows the duodenal tube to pass the pylorus. From 50 to 100 c.c. of sterile 25 per cent. saturated solution of magnesium sulphate is then injected into the duodenum in order to cause a relaxation of the intestinal wall. The bile is aspirated and studied. Lyon believes that by a study of the various characteristics of the bile thus aspirated it is possible to differentiate between normal bile, bile from an infected gall-bladder or duct, and in some cases to diagnose the presence of gall-stones.

Duration and Prognosis.—The *duration* of catarrhal jaundice varies from two to eight weeks. If the symptoms continue longer than two months, grave doubts may be entertained as to the case being one of simple jaundice. The prognosis is guardedly favorable. A rise of temperature usually indicates mischief (Pepper), while hemorrhages of the skin and mucous membranes always influence the issue unfavorably.

Treatment.—The *diet* and *hygiene* are the first considerations in the treatment. Rich, highly seasoned foods, rich pastries, fats, and sweets, are to be interdicted; starchy foods, lean meats, bread, soups (containing no fat), and green vegetables may, however, be used in moderation. Skimmed milk, butter-milk, and alkaline drinks (Vichy and Saratoga mineral waters) may be used freely, while sour wines, lemonades, and tamarind-water are allowable. Systematic bathing (Turkish or Russian baths, under supervision) and regulated hours of sleep exert a beneficial effect. The free use of pure water often does good by increasing the flow of bile and by dislodging plugs of mucus.

Gerhardt and Kraus have recommended the faradic current, applied over the region of the gall-bladder; manipulation has also been tried with a view to removing the obstruction, but without success.

The first *therapeutic indication* is to keep the bowels freely soluble by the use of saline aperients. In obstinate constipation calomel or rhubarb may be employed.

Conspicuous among other remedies may be mentioned the alkalies, sodium bicarbonate, salicylate, and phosphate, which tend to increase the flow of bile and render it less thick; hydrochloric acid (which, according to Ewald, by aiding digestion prevents the formation and consequent absorption of toxic substances) in combination with the bitter tonics—gentian, quassia, and *nux vomica*; ammonium chlorid which sometimes proves beneficial; and silver nitrate (gr. $\frac{1}{8}$ to $\frac{1}{4}$ —0.008–0.016, thrice daily).

Injections of cold water (60° to 70° F.—15.5°–21.1° C.) daily, in quantities of 1 or 2 quarts (1–2 liters), are highly recommended as promoting the secretion of bile; while lavage, practiced daily and over a protracted period of time (one to two months), has proved highly beneficial, especially when gastro-duodenal catarrh has existed.

Itching.—This troublesome symptom may often be relieved by the external application of a solution of borax or sodium bicarbonate (3ss to Oj—15.0-

¹ *Jour. Amer. Med. Assoc.*, 1919, lxxiii, 980.

500.0), or of menthol and alcohol (gr. x to ʒj—0.6–30.0). Internally, large doses of the bromids or the continued use of pilocarpin, as recommended by Witkowski, are worthy of a trial.

Flatulence.—To this end it is important to regulate the diet, avoiding starches and sugars. Charcoal tablets, bismuth subnitrate or salicylate, and beta-naphthol are all useful. Irrigation of the colon with some efficient antiseptic in solution is often a factor of service.

Headache is caused by the circulation in the blood of some toxic principle. Of drugs, caffein citrated, camphor monobromated, and acetphenetidin, either singly or in combination, may be recommended.

When the obstruction is due to mechanical causes (biliary calculi, tumors pressing on the duct) the treatment is surgical.

ACUTE INFECTIOUS CHOLECYSTITIS

Definition.—An acute inflammation (infective) of the gall-bladder.

Pathology.—Five pathologic varieties—catarrhal, suppurative, phlegmonous, gangrenous, and membranous—are recognized. The gall-bladder progressively enlarges and becomes filled with mucopurulent or purulent or (rarely) hemorrhagic material. The cystic duct is often occluded. In the suppurative form ulcers may coexist and perforation, followed by localized peritonitic abscess or acute diffuse peritonitis, may occur. The lesions of cholangitis, either catarrhal or suppurative, and also cholelithiasis, may be associated. Cholecystitis may exist without gall-stones.

Etiology.—The *bacterial* excitants include the streptococci, staphylococci, the pneumococcus, the colon bacillus, and the typhoid bacillus.

Among predisposing conditions are many of the acute infections, as typhoid, typhus, malaria, sepsis, pneumonia, puerperal fever, and cholera. Brown¹ is strongly of the opinion that cholecystitis is commonly a blood-borne infection from a focal source, such as the tonsil. He bases this opinion in part on experimental work in which streptococci isolated from the tonsils of patients suffering with cholecystitis showed an elective affinity for the gall-bladder of animals.

DaCosta has collected 58 cases of typhoid cholecystitis. His figures show that it may occur at almost any age, and of 48 cases in which the sex was stated, 26 were males and 22 females.

Symptoms.—The onset is abrupt, with pain (often paroxysmal) in right side of the abdomen or epigastrium. The region of the gall-bladder is acutely sensitive, and with the development of spreading peritonitis the tender area grows correspondingly. Rigidity of the right rectus may be observed. In many cases a tumor occupies the seat of the gall-bladder. It is detected on palpation as a firm, pear-shaped tumor or as a “mere resisting mass below the costal margin.” The latter is often due to peritonitic abscess following perforation.

Nausea and *vomiting*, which may be persistent, are usual symptoms at the onset. *Jaundice* occurred in 17 out of 58 cases (DaCosta). Among the general symptoms chills are conspicuously absent. *Fever* may be present, but by no means always; the pulse becomes rapid and feeble, the abdomen distended, and prostration profound. Bayard Holmes noted cardiac disturbance as the most characteristic symptom in 46 cases. In the suppurative form a blood examination generally shows leukocytosis. The writer has reported 3 cases of cholecystitis complicating lobar pneumonia. Jaundice occurred in 2 of the cases. This serious affection may be entirely latent.

Differential Diagnosis.—*Appendicitis* may be mistaken for cholecystitis, particularly if the appendix be situated abnormally high up. The

¹ Arch. Int. Med., 1919, xxiii, 183.

discrimination would here rest upon the history (following typhoid or other infection), the presence of a *tumor* and marked sensitiveness in the region of the gall-bladder, corroborated by jaundice.

Acute intestinal obstruction may be closely simulated in cases in which adhesions between the gut and gall-bladder are present. In such cases exploratory celiotomy is to be advised or at least considered with a view to clearing the diagnosis. *Recurrent cholecystitis*, a not uncommon complaint, gives the history of recurring attacks of pain simulating cholelithiasis. In one of my cases Laplace operated and found the gall-bladder somewhat enlarged and the seat of catarrhal cholecystitis. Osler suggests that in some of these cases gall-stones may have been present and have passed before the operation (*vide infra*).

Prognosis.—This is dependent upon the special variety, although it is among the most fatal of diseases. A fatal result is the rule in purulent and phlegmonous cholecystitis. In the catarrhal form recovery is not infrequent (DaCosta). Pneumococcal cholecystitis is more acute and severe than that due to colon or typhoidal infection (Richardson). Gangrenous cholecystitis is rare and quite fatal.

Treatment.—This embraces absolute rest, rectal alimentation, the relief of pain by the judicious use of morphin, and of other symptoms as they arise. Stimulants are necessary as a rule. If the diagnosis of suppurative or phlegmonous cholecystitis can be established, surgical intervention is imperatively demanded as a rule.

Chronic Cholecystitis.—By this term is meant chronic inflammation of the gall-bladder, either secondary to an acute cholecystitis or a chronic low-grade infection from the beginning. It cannot be differentiated clinically from cholelithiasis, with which it is associated in the majority of cases.

CALCULOUS CHOLECYSTITIS

(*Biliary Calculi; Gall-stones; Cholelithiasis*)

Definition.—Concretions formed in the gall-bladder, usually due to infection of its walls; they set up characteristic disturbances.

Etiology.—Catarrhal inflammation of the gall-bladder excites pathologic production of cholesterin by perverting metabolism inside the mucus-secreting cells in its walls. Infective catarrh of the small intrahepatic ducts leads to an albuminous exudation, which precipitates bilirubin-calcium calculi in the bile. Rothschild and Wilensky¹ believe that in men gall-bladder disease is most frequently infectious in character, whereas in women (this statement applies to women who have born children) during the occurrence of pregnancy there is a marked hypercholesterinemia; this leads to a marked increase in the cholesterin content of the bile. From this it may be inferred that the metabolic elements responsible for the increase in cholesterin are responsible for the production of the pathologic stones in the gall-bladder. Scheel found gall-stones in 15 per cent. of 2753 cadavers. In 67 per cent. of those showing gall-stones the bile passages were apparently not pathologic. The *exciting* cause is an infective inflammation of the gall-bladder and bile-ducts due to various organisms—*e. g.*, the *colon bacillus* and the *typhoid bacillus*. Among **predisposing causes** are: (a) *Female sex*, especially between the ages of forty and sixty. Senac's statistics, out of a total of 311 individuals, give 227 women (Dujardin-Beaumetz). (b) *Stagnation of bile*, due to an *excessive diet of starches and of fats*, a sedentary life, constipation, tight lacing, pregnancy, obesity, chronic obstruction to the outflow of bile (tumors, visceroptosis). Kehr claims that stones can develop in sterile bile when the flow is obstructed. (c) It may occur during childhood. (d) Disorder about the pancreas may be the cause of gall-stone formation (Croftan).

¹ *Amer. Jour. Med. Sci.*, 1918, clvi, 239.

(e) Insanity, particularly chronic melancholia. (f) Incidence. Brockbank found among 13,047 completed postmortem records 7.4 per cent. of gall-stones.

Composition and Appearance.—Gall-bladder calculi are formed principally from cholesterin mixed with some bilirubin-calcium from the earliest stage. Certain salts (lime, potash, soda, traces of iron, and copper) also enter into the composition. Those formed in the hepatic ducts are composed of bilirubin-calcium alone. In *size* they vary from the smallest particle of sand to that of a goose egg. Fagge reports a calculus weighing, in a dry state, 462 grains (30.0). The *color* varies from white or light yellow to that of a dark green (pigment-lime calculi), and may present any variation between these two extremes. The *nucleus* often consists of cholesterin, the outer layer being usually the harder, and made up, for the most part, of lime-salts. The cholesterin gall-stones cut like wax, are white, and the cut section presents a crystalline appearance. Other forms are apt to be brittle. The *surfaces* may be smooth, striated, or hollowed out, solitary calculi being usually round or ovoid, while multiple stones often present smooth facets due to the massing together of the calculi (Dujardin-Beaumetz). They are usually olive shaped, but may be pyramidal, cylindric, lenticular, pisiform, cubic, finger shaped, or olivary. Their *seat* is usually the gall-bladder, but they may be found anywhere along the biliary passages, or may be truly intrahepatic.

Symptoms.—The passage of a calculus through the duct, if it sets up a “perialienitis” or inflammation of the structures surrounding it (*cholecystitis*), will give rise to *hepatic colic*, whereas a permanent blocking of the duct will cause symptoms of chronic obstruction (*vide infra*).

Hepatic Colic.—When a gall-stone becomes impacted in a bile-duct the patient experiences *agonizing pain* (tearing, cutting, or lancinating in character) in the right hypochondriac region, radiating to the right shoulder, and accompanied often by profuse *sweating*, *vomiting*, and a *feeble, running pulse*. The most common *seat* of the pain is 2 to 3 inches to the right of the median line and about an equal distance below the ensiform cartilage. Less frequently it is in the region of the gall-bladder. This happens in cases in which the gall-stone is impacted in the cystic duct, and may be due either to distention of the gall-bladder or, more commonly, to associated cholecystitis. Hepatic colic, however, may occur independently of the passage of biliary calculi, as from non-calculous cholecystitis (Stockton, Riedel). If pain is severe without relation to meal-time, you should suspect cholelithiasis. On the other hand, large calculi have been found in the dejecta without having excited hepatic colic. I saw an instance in which the gall-stone was the size of an English walnut. A *rigor* or *chill* often precedes the attack, which is usually accompanied by moderate *fever* (Charcot’s intermittent fever), the temperature reaching 101° to 102° F. (38.3°–38.8° C.). If the stone passes through the common duct without becoming impacted, jaundice and pain may be absent. When, however, occlusion of the common duct occurs, the *jaundice* becomes intense. This symptom may be present, though less marked, before the gall-stones reach the *ductus communis*. Jaundice occurs in about 50 per cent. of the cases (Fitz), and it sets in within forty-eight hours after the onset of the attack. *Physical examination* reveals on inspection a slight prominence in the hepatic area, and on palpation the edge of the liver can often be distinctly felt below the costal margin—at times as low as the umbilical level; it is sensitive on pressure, and particularly the gall-bladder, which can often be palpated. If the latter viscus contains many calculi, and the abdominal wall is relaxed, crepitation may be noticeable to the palpating fingers (rarely). Tenderness in Boas’ area to the right of the spine between the tenth and twelfth rib is a valuable confirmatory sign. The swollen organ, after the cessation of the colic, quickly subsides. Tenderness over Mayo Robson’s point at the junction of the lower

third with the upper two-thirds of a line drawn from the tip of the ninth rib to the umbilicus is a characteristic feature. *Recurrences* of the attacks after varying intervals of time are common, and in the female especially at the menstrual period. Finally, the gall-stone may be expelled and the colic cease to return. Multiple stones, however, may be passed. Hyperchlorhydria is commonly present.

Rupture of the duct, followed by fatal peritonitis, has been known to occur. Localized peritonitis results from extension of inflammation through the walls of the gall-bladder. Biliary colic is of variable *duration*, lasting from a few hours to a few days or one or more weeks even. The blood cholestrin is usually increased, though not necessarily. Hypercholesteremia frequently occurs in many of the conditions often associated with gall-stones (pregnancy, obstructive jaundice, severe diabetes, etc.). Examination of the *urine* after the paroxysm reveals bile, uric acid, and urates. The *pulse* often becomes slowed. Exner found about 0.4 per cent. of sugar in the urine in 39 out of 40 cases of gall-stones. On the other hand, Kausch has found glycosuria in only 1 of 85 cases.

The **prognosis** as regards life is good, but as regards recovery only guardedly favorable. Cardiac distress with palpitation may occur during hepatic colic and form a serious complication. Fatal syncope has also been known to occur, and gall-stone ileus, especially near the ileocecal valve, may terminate life. If evidences of an infectious inflammation arise, the outlook is then more serious. The sequelæ will be discussed hereafter (*vide infra*).

The **diagnosis** of gall-stones is sometimes difficult on account of the obscure clinical symptoms and the absence of physical signs. When, however, the calculus becomes impacted in the duct, symptoms of biliary colic—intense pain in the epigastrium and right hypochondriac region, radiating to the back and right shoulder—usually appear. The attack is of brief duration, with abrupt cessation. There are also fever, vomiting, and in one-half the instances jaundice. The urine should be examined early, since bile may be present many hours before icterus occurs. Pfahler¹ claims that in 50 per cent. of the cases gall-stones are demonstrable by the roentgen rays. Biliary calculi are not often found in the dejecta.

Differential Diagnosis.—*Gastralgia* occurs in neurotic individuals, and is characterized by severe paroxysmal pains in the epigastrium, extending to the back and base of the chest. It occurs when the stomach is empty and is relieved by eating. Firm pressure over the epigastrium often alleviates the pain temporarily, and the absence of fever, jaundice, stones in the dejecta, and the negative urinalysis, together with the history of former attacks, would tend to differentiate it from hepatic colic.

Renal Colic.—The pain in this condition starts in the flank of the affected side and is transmitted down the ureter, and there is localized tenderness. The testicle and inner side of the thigh are very painful, the former being often retracted. Micturition is frequent and sometimes painful, and the urine is scanty in amount and often mixed with blood.

Intestinal Colic.—In this variety the pain is of a boring or twisting character, usually centering about the umbilicus. It is relieved by firm pressure. Abdominal distention is often present, and relief comes with the passing of flatus. Usually there is a history of an indiscretion in diet. When due to *lead-poisoning*, the history, the blue line on the gums, and the presence of wrist-drop would tend to confirm the diagnosis.

Reflex colic, due to uterine or ovarian disease, may also occur. The recurrence of the attacks, together with causes and symptoms pointing to pelvic disease, would establish the identity of the condition.

¹ *Jour. Amer. Med. Assoc.*, April 25, 1914, p. 1304.

CHRONIC OBSTRUCTION OF THE DUCTS BY GALL-STONES

The obstruction may exist either in the common or the cystic duct.

1. Obstruction of the Common Duct.—Pathology.—The result of the irritation produced by the presence of the stone is a catarrhal process (*cholangitis*) that may either remain chronic or terminate in suppuration (*suppurative cholangitis*). In a case of simple obstruction the gall-bladder is often moderately enlarged, though rarely extending below the lower border of the liver. The common duct is greatly distended, the stone being usually located near its termination. Occasionally two or more calculi are present, completely obliterating the canal. The hepatic duct and its branches are greatly dilated, and often contain thin, colorless mucus, the lining membrane being smooth and clear. The liver in these cases is firmer in consistency than normal, showing some increase in the connective-tissue element (biliary cirrhosis). Following moderate enlargement of the organ progressive atrophy may rarely occur. When *suppuration* has occurred the mucous membrane is greatly swollen and reddened, and in some instances shows erosion or ulceration (*ulcerative angiocholitis*). The process often ascends the hepatic ducts into the liver, with infection of this organ, and in the severer cases abscess formation. On the other hand, it may extend to the gall-bladder, giving rise to empyema of the latter. In some instances the gall-bladder has been perforated and abscesses have formed between the liver and stomach. *Diver ticula* are sometimes found postmortem, containing biliary calculi.

While cholelithiasis is a common cause of catarrhal, suppurative, and ulcerative angiocholitis, it not rarely complicates hydatid disease, carcinoma of the bile-ducts, and the acute infections, particularly typhoid fever (*vide* Acute Infectious Cholecystitis, p. 859). Rarely foreign bodies (fish-bones, lumbricoids) operate as excitants.

Symptoms.—Chronic obstruction by gall-stones, with coexisting *catarrhal inflammation* (catarrhal angiocholitis), is characterized by a distinctive group of symptoms, among the most prominent of which are—

Jaundice.—This may be constant and very intense, or intermittent and slight, depending upon the amount of obstruction present. There are periodic elevations of temperature accompanied by a deepening of the jaundice, when this symptom already exists (ball-valve action of the stone). *Itching* is, as a rule, a most distressing feature. A stone low down produces obstruction also of the pancreatic ducts, in which case the stools will contain a great amount of fat and undigested muscle-fibers.

Pain, occurring in paroxysms and referred to the region of the liver. This is accompanied by fever that may reach a high degree (102° to 103° F.—38.8°–39.4° C.), also by chills and sweating, resembling the paroxysms of malaria. Painful points in the right side posteriorly may be annoying; these are either constant or paroxysmal.

The *chills* are often intense, and may present a quotidian, tertian, or quartan form. The temperature of the intervals is normal. The peculiar exacerbations of temperature were first described by Charcot, and to them has been given the name of *Charcot's intermittent fever*. Concerning their nature Murchison writes: "These paroxysms may be more or less periodic, and may extend over several months, without necessarily indicating pyemic hepatitis, the patient ultimately recovering." He adds that they are probably analogous to febrile paroxysms produced in passing a catheter along the urethra. Charcot believes the etiologic factor to be a septic poison, bacterial in origin and the result of chemical changes in the bile. Various micro-organisms have been detected in the bile in such cases (*Bacterium coli commune*, *Streptococcus pyogenes*, et al.).

Gastric Disturbances.—These may excite alarm during the paroxysm. Intense pain is complained of in the epigastrium, accompanied often by nausea and vomiting, which, however, usually subsides at the close of the paroxysm, while the jaundice at this time deepens. Lichty found disturbance of the gastric secretion in 75 per cent. of the cases, of which two-thirds showed hyperchlorhydria. Gastric motility was disturbed in about the same proportion of cases.

The symptoms of *suppurative cholangitis* are intense. The *paroxysms* of fever occur more frequently, the temperature merging into the remittent type. Grave constitutional symptoms, indicating septicopyemia, are present, and the case rapidly tends to a fatal issue. The attacks of colicky pain occur with jaundice, but the latter symptom is less intense than in the catarrhal form. As to hepatic enlargement, the converse is true; this organ takes on progressive enlargement and “may descend as low as the umbilicus, the swelling being uniform and smooth and tender to pressure” (Robson). It should be borne in mind that pain may be absent when the disease is not dependent on gall-stones. Pneumonia and empyema are serious and not uncommon complications. In *ulcerative angiocholitis* severe hemorrhage may occur, resulting either in melena or hematemesis. Mayo Robson reports a case in which hematemesis was the only antemortem symptom and had been the cause of death. The process being a septic one, it leads to the constitutional disturbances of septicemia or septicopyemia. *Pancreatitis* may be caused by stones in the common duct.

2. Obstruction of the Cystic Duct.—This almost invariably causes distention of the gall-bladder (dropsy of the gall-bladder). If obstruction of the cystic duct alone occurs, *jaundice* may be entirely absent, the bile in the distended tissues being replaced by a thin, mucoid fluid. This is more apt to exist as the obstruction becomes more chronic. In some instances the distention is so great as to reach below the umbilicus, and the dilated viscus has even been mistaken for an *ovarian tumor*. Osler records a case in which 18 oz. (540.0) of fluid were removed from the gall-bladder. The contents are neutral or alkaline in reaction, albumin often being present in abundance. Catarrhal inflammation of the gall-bladder may be associated, causing *pain*, at times being so severe as to simulate hepatic colic, and *sensitiveness* in the region of the organ, although, as a rule, few symptoms are presented. The examiner can *feel* an elastic, gourd-shaped tumor closely connected with the liver, movable in respiration in the vertical, and also, under the influence of the palpating fingers, in the lateral direction. Occasionally Riedel’s tongue-like projection of the anterior margin of the right lobe is palpable. Given a gall-bladder well filled with stones and a relaxed abdominal wall, gall-stone crepitus may be detectable.

I have reported some cases giving a more or less characteristic clinical history of cholelithiasis, in which gall-stone crepitus on palpation furnished proof of stones in the gall-bladder. In one case I combined auscultation with palpation and detected a grating sound. Rydgaard¹ found that 74 per cent. of 135 patients with gall-stones obstructing the cystic duct had achylia or hypochylia.

If the obstruction persists for a length of time, calcification or atrophy of the bladder are common sequelæ. Complete obliteration of the cavity of the gall-bladder may ensue.

Among rarer sequelæ of chronic obstruction may be mentioned: (a) *Empyema of the Gall-bladder.*—When this takes place the organ becomes greatly distended, and has been known to contain as much as 1 pint of purulent material. The *symptoms* of suppurative cholecystitis simulate and accompany

¹ *Hospitalstidende*, Copenhagen, Jan. 14, 1920, p. 17.

those of purulent cholangitis; they are sometimes preceded by those of catarrh of the gall-bladder and ducts. Perforation may occur, giving rise to circumscribed periportal abscesses or to generalized peritonitis (see also Acute Infectious Cholecystitis, p. 859).

More Remote Effects of Gall-stones.—These will be spoken of under three headings:

1. Stricture of the duct, resulting from ulceration and cicatrization produced by the passage of a stone.
2. Intestinal obstruction, due to impaction of stones or volvulus.
3. Biliary fistulæ resulting from perforations.
4. Chronic pericholecystic adhesions.

1. **Stricture of the Duct.**—Obliteration of the common duct may result from the passage of a gall-stone, giving rise to ulceration and cicatrization, or the stone may become impacted and lead to adhesions and permanent closure of the duct below it (Murchison). When due to ulceration the seat of the stricture is usually low down in the common duct.

The *symptoms* are those of chronic obstructive jaundice (Osler). In many cases there will be an antecedent history of the passage of gall-stones. In all cases in which the symptoms of gall-stones are followed by permanent jaundice without pain it may be suspected either that the calculus has become firmly impacted or that it has produced organic stricture or closure of the duct.

2. **Intestinal Obstruction from Impaction of Gall-stones.**—The ileum is commonly the seat of obstruction by gall-stones that may give rise to intussusception or cause ulceration and gangrene of the bowel with perforation and fatal peritonitis. The latter event, however, occurs more frequently when the biliary concretions are situated in the cecum. Rarely they are found in the appendix, and may produce appendicitis. Cases of impaction in the rectum of biliary calculi have been recorded. I saw a case with the late Dr. R. Bruce Burns.

Symptoms.—If the impaction occurs in the small intestine, the abdomen becomes tympanitic and tender on pressure. The contents of the stomach are first vomited, followed by bile and stercoraceous matter. Symptoms of peritonitis develop and continue until either the impaction disappears or death ensues. Ileus, the result of biliary concretions, is common in females of advanced age, and adhesions about the gall-bladder region may obstruct the lumen of the bowel. The history of previous acute attacks would tend to confirm the diagnosis. The pain is intense. The duration of the last attack is often short.

3. *Perforation* may occur with the establishment of *fistulous communications* between the gall-bladder and stomach, intestinal canal, bladder, vagina, lungs, abdominal parietes, or portal vein. Fistulæ between the gall-bladder and stomach are rare, though cases are recorded by Oppolzer, Frerichs, Cruveilhier, Murchison, and others. Cruveilhier states that vomited gall-stones necessarily reach the stomach through fistulous tracts, as the passage through the pylorus would be impossible.

Fistulæ into the duodenum are of much more common occurrence, ulceration taking place usually in the fundus of the gall-bladder and in the descending or third portion of the duodenum: 39 cases are recorded of fistulous communication with the colon (Osler). I have reported a fortieth case. In 6 of 9 cases reported by Murchison carcinoma of the gall-bladder was present. Fistulæ into the urinary passages may occur, 2 authenticated cases being reported. The distended gall-bladder may come in contact with the urinary viscus, or the stone may perforate into the pelvis of the kidney and pass through the ureter into the bladder.

Fistulous openings through the abdominal parietes are the most common, the place of exit of the biliary concretions being usually in the region of the gall-bladder or at the umbilicus, to which it may be directed by the suspensory ligament of the liver. As many as 600 stones have been removed from the gall-bladder in this manner. Advanced life and female sex are said to be predisposing causes. Courvoisier's statistics show 184 cases, in 78 of which recovery took place.

Fistulæ into the pleura, bronchi, and vagina have been recorded, but are extremely rare. Courvoisier records 24 cases of fistulæ into the lungs, only 7 of which terminated in recovery. Fauconneau, Dufoesne, Frerichs, Bristowe, and Murchison mention cases of fistulæ into the portal vein, with the presence of biliary concretions in the latter.

4. Chronic Pericholecystic Adhesions.—Adhesions which are due to previous infectious inflammation, either acute or chronic, of the biliary tract are of frequent occurrence. Their pathogenesis is analogous to that seen elsewhere in the body (*e. g.*, appendix).

Symptoms.—The clinical recognition of the adhesions offers formidable difficulty. More or less periodic attacks of biliousness and indigestion without apparent cause, and accompanied by pain and tenderness to deep pressure over the region of the gall-bladder or pylorus, with rigidity of the overlying muscles, form a grouping of significant diagnostic points. A roentgen-ray examination should be undertaken. Either the pylorus or duodenum may become obstructed, with ensuing gastrectasis.

Diagnosis.—I would strongly urge an exploratory celiotomy as an accurate means of diagnosis in obscure cases.

Treatment of Foregoing Conditions.—The indications for treatment in *cholelithiasis* are: (a) to remove the cause; (b) to relieve the paroxysms of hepatic colic, and (c) to adopt palliative or radical measures for the removal of the stones.

Preventive Treatment.—This has reference to the removal or mitigation of the predisposition. The diet should be as simple as possible, consisting largely of skimmed milk, lean meat, eggs, fruit, and green vegetables. Fatty foods, sugars, starches, and pastries are to be strongly interdicted. All foods should be thoroughly masticated, so as to digest easily, and meals should be taken at regular intervals. Systematic exercise in the open air is of signal value, as it stimulates the flow of bile. Punkhauer strongly recommends horseback-riding for obstructions in the common duct. Drugs that have supposedly an influence upon hepatic function are chiefly the salicylates and ox-gall. In my own experience 1 dram (4.0) of sodium phosphate dissolved in a glass of hot water in the morning on rising has yielded excellent results. The same dose may be repeated before the noon and evening meals, if required. Constipation should be carefully avoided.

To prevent recurrences a course of alkaline treatment at some of the more noted mineral springs (Bedford, Vichy, Carlsbad) is often attended with good results. The efficacy of the Carlsbad treatment lies in reducing inflammatory processes, and not in the expulsion or solution of the gall-stones. "As the result of Carlsbad treatment, Fink, in 375 cases, had good results in 291 = 72.8 per cent., of which 20 cases, or 4.95 per cent., had relapse" (Forcheimer).

Treatment of the Paroxysm of Biliary Colic.—At the very onset of an attack of hepatic colic the prompt exhibition of morphin or of codein may greatly mitigate an attack.. The former may be given hypodermically in $\frac{1}{8}$ - to $\frac{1}{4}$ -gr. (0.008–0.016) doses every hour until relief follows; the latter is exhibited by the mouth in doses of 1 gr. (0.065) every hour. Inhalations of chloroform, with morphin hypodermically, the former being continued until the latter

has taken effect, is the typical treatment of an attack. Gilman Thompson recommends chloroform (mxx—1.3) by mouth for the relief of pain.

Hot baths and hot applications (with counterirritation) over the liver are valuable aids in the treatment of hepatic colic, being given at a temperature of 98° to 100° F. (36.6°–37.7° C.), and continued for twenty minutes, if endurable, so as to effect relaxation. If cardiac depression results and the pulse becomes weak, the baths should be discontinued. Hot flaxseed-poultices, cloths wrung out of hot water, hot hop-bags, or turpentine stüpes may be applied over the hepatic region until the attack subsides. Ice-poultices have been advised by Buchetan.

If shock or syncope should develop, the body-temperature must be maintained by hot bottles or bricks placed in contact with the surface of the body, together with strychnin (gr. $\frac{1}{80}$ —0.0021), atropin (gr. $\frac{1}{160}$ —0.00042), and brandy (1 dram—4.0) hypodermically.

Nausea and *vomiting* may be reduced by 15-drop doses of spirits of chloroform every half-hour; also by brandy or champagne.

In mild cases sodium salicylate (gr. viij to xv—0.5–1.0 in twenty-four hours), recommended by Prevost and Binet, or codein (gr. j—0.06), with phenacetin (gr. x—0.6), every few hours gives relief. Purgation and remedies presumed to act as cholagogues, given during an acute seizure, are harmful in their effects. The aim should be to reduce the inflammatory process in the gall-bladder. D. D. Stewart well says: "The treatment of recent cases of stone in the common duct belongs to the physician but a short time only." If the gall-bladder is palpable after an attack of hepatic colic, the cystic duct is probably obstructed and the treatment is surgical.

Treatment for Removal of Gall-stones.—Solvents for the stones have been tried at various times, among them being *Durande's method* (turpentine and ether), but so far all such methods of treatment have been unsuccessful.

Of the various surgical measures for the removal of gall-stones the following are the chief: (a) Removal of the stone from the common duct (choledochotomy); (b) removal of the stone from the cystic duct (cholecystotomy); (c) establishing a fistulous opening between the gall-bladder and the bowel (cholecystenterostomy); (d) extirpation of the gall-bladder (cholecystectomy), the latter operation giving a mortality of 17 per cent., according to Murphy's statistics. And operative procedure is indicated in infectious (suppurative) cholecystitis as well as in infectious (suppurative) cholangitis; *e. g.*, evacuation and drainage. W. Mayo has operated on 510 cases of cholelithiasis with a death-rate of only 3 per cent. Of 326 cases of gall-stones complicated with biliary infection and malignant disease, 16, or 5 per cent., proved fatal. Kehr has never had a recurrence in 900 operations for cholelithiasis; Toeplitz has had recurrence in 14.2 per cent.

CARCINOMA OF THE BILE-DUCTS

Carcinoma of the gall-bladder and bile-ducts may occur as a primary disease and exist over a long period of time without being recognized.

Pathology.—The gall-bladder, as the result of obstruction of the duct, is often greatly distended, measuring as much as 7 inches (17.7 cm.) in length (in a case reported by Harley) from the entrance of the duct to the fundus, and being filled with a cloudy liquid, somewhat resembling barley-water, that contains flakes of epithelium, granular matter, and particles of inspissated bile. If the growth be near the duodenal orifice, the common and cystic ducts are often greatly distended, and the dilatation may extend into the he-

STENOSIS OF THE BILE-DUCTS

Stenosis may result from any of the following causes: (a) *Round-worms* in the duct (rarely); (b) foreign bodies, as seeds; (c) ulceration and cicatrization following the passage of gall-stones (most commonly); (d) pressure from without, as from tumors (carcinoma chiefly) of the head of the pancreas and pylorus (rare); (e) abdominal tumors; (f) aneurysm of the abdominal aorta or of the celiac axis (rare); (g) secondary enlargement of the lymphatics of the liver (common); (h) more rarely in man than in the lower animals *Distoma hepaticum*, or liver-flukes and echinococci; (i) adhesions due to chronic peritonitis.

Pathology.—If the stenosis is of recent origin the liver is enlarged and shows more or less congestion, with some increase of the connective-tissue elements. The substance is firmer than normal, the color varying from an olive green to a deep bronze. If, however, the obstruction be of long standing, the presence of the dilated intrahepatic ducts and the increase of connective tissue cause secondary atrophy of the hepatic cells, with a diminution in the size of the organ.

The symptoms vary greatly according to the cause of the stenosis, but in the main they are those of chronic obstruction of the duct—viz., paroxysmal pain in the region of the liver, referred to the right shoulder; jaundice of varying intensity, but gradually deepening after each attack; and gastric disturbance, with ague-like paroxysms (fever and sweating), the latter being most frequently met with in occlusion from gall-stones.

Diagnosis.—The pathognomonic symptoms determining the nature of the stenosis are very often wanting, and the diagnosis is rendered correspondingly difficult. On the other hand, stenosis or complete occlusion of the bile-passages calls for diagnosis principally on account of the special cause or causes of the given case.

When the condition is due to *lumbricoid* worms reflex symptoms usually appear, as pruritus of the nose and anus, grinding of the teeth during sleep, and convulsions.

In *carcinoma of the head of the pancreas or the pylorus* pressing on the ducts the growth may be detected by palpation, together with a recognition of more or less characteristic features (*vide* Carcinoma of Pancreas), and the rapid course of the disease.

Abdominal aneurysm may give rise to obstruction of the duct without being evidenced by physical signs. Usually, however, when the sacculation presses against the bile-duct, the throbbing in the epigastrium, the tumor (which can often be grasped), and the expansile pulsation on palpation will tend to establish the cause of the obstruction.

When due to *cancerous nodules in the liver* there is usually a history of primary carcinoma of the stomach, mammary gland, rectum, or of one of the pelvic viscera. Osler records a case in which jaundice (thought to have been catarrhal in origin) developed seven weeks previously. On careful examination "a small nodule was detected at the umbilicus, which on removal proved to be scirrhus."

When the stenosis is due to *ulceration* following the passage of gall-stones, the history of biliary colic, and of paroxysmal pain with jaundice and intermittent fever, will serve to establish the cause.

If the fever be of the continued type and the liver uniformly enlarged, with the development of jaundice, the case is probably one of *hypertrophic cirrhosis*; whereas if the enlargement be progressive and nodules can be detected on palpation in addition to the appearance of cachexia and jaundice, *carcinoma* is undoubtedly present.

Physical signs aid but little in the diagnosis, as obstruction of the common duct is usually unattended by any great enlargement of the gall-bladder.

In many cases only by remembering the various causes and eliminating them carefully, one by one, can a diagnosis be rendered.

The **prognosis** varies according to the cause of the stenosis. Generally speaking, the outlook is rather grave, since many of the causative conditions are fatal. If the obstruction is due to cicatricial contraction, the prognosis is guardedly favorable as to life, but hopeless as to recovery. If the obstruction is permanent, the case ends fatally.

The **treatment** of occlusion of the bile-ducts varies according as it is due to cicatricial contraction following ulceration or to foreign bodies (seeds or lumbricoid worms), or to gall-stones or tumors pressing upon or involving the ducts or adjacent organs (pancreas, pylorus). If the stenosis follows ulceration in the duct, and is sufficient to cause almost complete occlusion with biliary retention, the operation of cholecystenterostomy may become necessary in order to prevent dilatation of the gall-bladder with resorption of bile.

Foreign bodies in the duct may be removed by free purging, aided by the liberal use of alkaline mineral waters. In critical cases the operation of cholecystotomy is recommended.

Gall-stones form the most frequent causes of stenosis, and the treatment, both for the prevention and removal of calculi, has already been described in the discussion of Biliary Calculi (*vide* p. 860).

ICTERUS NEONATORUM

Definition.—By the term “icterus neonatorum” is meant jaundice occurring in the newborn. It is seen in about two-thirds of all newborn infants, is unaccompanied by any other lesions, and pursues a favorable course. Icterus neonatorum must not be confounded with jaundice occurring in the newborn and dependent upon various pathologic causes—*e. g.*, congenital stricture or absence of the duct, syphilitic disease of the liver, duodenal catarrh, and septicemia, as a result of infection through the umbilical vein. In this form the skin and conjunctivæ are more or less icteroid, the urine is loaded with bile-pigment, while the feces are of a pipe-clay variety. Hence it differs in its symptomatology from true icterus neonatorum.

The secretion of bile begins before birth, and Zweifel found bile-pigment and bile-acids in the contents of the intestines of a three-month fetus. Hence well-marked jaundice may be a congenital condition.

Etiology.—The following are the main causes: 1. The ductus venosus may remain patulous, allowing some of the portal blood, containing bile, to flow into the systemic circulation (Quincke). 2. Diminished pressure in the portal vessels from ligation of the umbilical vein causes increased tension in the hepatic capillaries and absorption of bile. 3. It is probable that the external conditions are in some way concerned in the appearance of the disease (Osler). 4. The destruction of red corpuscles may be followed by an increased amount of bile-pigment in the liver.

Symptoms.—The skin is tinted greenish yellow, resembling somewhat that of chlorosis. The mucous membranes are pale and the conjunctivæ pearly white except in the severer cases, when they show a slight discoloration. The icterus usually appears on the second or third day of life. The pulse is feeble and sometimes rapid. Auscultation over the base of the heart often reveals a soft systolic murmur, associated with a venous hum in the neck. According to Murchison, icterus neonatorum differs from the pathologic form

in that—(1) the conjunctivæ are of a natural color; (2) the urine is free from bile-pigment; (3) the yellow color gradually fades from the skin after a few days; (4) the child is quite well and the bowels are acting properly.

Prognosis.—The jaundice gradually disappears spontaneously at the end of three or four days.

Treatment.—As a rule, nothing beyond hygienic measures are required. The diet need not be restricted.

VASCULAR (CIRCULATORY) AFFECTIONS OF THE LIVER

ANEMIA

The physical symptoms of this condition are absolutely *nil*, and its existence only discoverable *postmortem*. Its most common causes are those of general anemia, fatty and amyloid degeneration.

HYPEREMIA

Definition.—An excess of blood in the liver. This may be of two varieties: (a) *active* and (b) *passive*, the latter being the more common.

ACUTE HYPEREMIA

(*Active Congestion*)

Definition.—An excess of arterial blood in the liver.

Etiology.—Among the common causes are luxurious living, sedentary habits, alcoholism, traumatism, acute infectious diseases (typhus, typhoid), and pernicious malaria. The condition may also be vicarious, due to a sudden cessation of menstruation or of hemorrhage in other parts of the body. A *physiologic* condition is the temporary hyperemia that occurs during the ingestion of a full meal.

Symptoms.—There are no symptoms characteristic of this condition; those present in the different cases are varied and referable to disturbances of other viscera, as in coexisting cardiac hypertrophy or gastro-intestinal catarrh. There is a sense of *fulness* and *distress* in the right hypochondrium, most marked during the height of the digestive process, with *tenderness* on palpation over the margin of the organ.

Prognosis and Course.—It is impossible to make any definite statement as to the course and prognosis of active hyperemia, these depending wholly upon the cause of the affection. When due to errors of diet and hygiene the condition is easily remedied; the prognosis of hyperemia accompanying hepatic cirrhosis, however, is decidedly grave.

PASSIVE HYPEREMIA

(*Passive Congestion*)

Definition.—An increase of venous blood in the liver.

Pathology.—The organ is enlarged and changed into a deep-red color, while its substance is firmer than normal. The center of the lobule (the area of the hepatic vein) becomes deeply pigmented, the periphery (occupied by the portal vein) being lighter in color, sometimes owing to fatty infiltration. Because of its mottled appearance this has received the name of “nutmeg liver.”

In long-standing passive congestion there is an increase of connective tissue, due to a proliferation of round-cells, causing atrophy of the parenchyma.

the veins; (e) it may be occasioned by ulcerative affections of the bowels and appendicitis, and pylephlebitis may precede its occurrence; (f) slowing of the circulation due to splenic diseases, such as marasmus. It is more common in males than females, and occurs at all ages.

Symptoms may be almost lacking in portal obstruction, or the condition may simulate cirrhosis of the liver. In ordinary cases the symptoms are very slight, the hepatic circulation, as shown by Cohnheim and Litton, being "sufficient for the nourishment of the liver and secretion of the bile" (Henry).

If the occlusion be *complete*, *edema* followed by the rapid development of *ascites* may occur. In such cases loss of strength is persistent and progressive, and death may result from exhaustion. *Hemorrhages* due to venous stasis may occur from the nose, stomach, and intestines. *Jaundice* and *diarrhea* occur frequently, the former being the result of obstruction to the biliary passages from the same causes that produce the thrombosis or of the diminished pressure in the portal area. On *palpation* the liver is found slightly enlarged and tender on pressure, and projecting below the lower margin of the ribs; the *spleen* is also enlarged. *Percussion* also reveals enlargement of the splenic area. If *ascites* is present, percussion will reveal dullness in the flanks, changing with the position of the patient; and on gently tapping one side of the belly wall, with the hand on the opposite side, a wave of fluctuation will be felt.

The **diagnosis** of portal thrombosis is often extremely difficult. "A suggestive symptom, however, is sudden onset of the most intense engorgement of the branches of the portal system" (Osler).

"Pylethrombosis may be regarded as probable if no other possible cause of the portal obstruction seems likely, and if we are able to discover a cause for thrombosis, like a former attack of circumscribed peritonitis" (Strümpell).

Sequelæ.—If the emboli are septic in origin, an abscess, with all its accompanying symptoms, will be the result. Hemorrhagic infarction may occur, but is very rare, since a free anastomosis exists between the lobular plexuses and the hepatic artery.

The **prognosis** is always unfavorable, although certain cases have been demonstrated by autopsy to have improved temporarily.

Course and Duration.—Nothing definite can be stated in regard to the course and duration, since these depend entirely upon the cause.

Treatment.—The symptoms resulting from portal congestion, due to thrombi in the portal vein, are those described under Cirrhosis of the Liver, and the treatment is identical with that of interstitial hepatitis. Septic emboli rarely give rise to abscesses; the treatment is symptomatic. It has been recommended to take the coagulation period of the blood, and if found to be abnormally brief, citric acid should be employed.

SUPPURATIVE PYLEPHLEBITIS

Definition.—A purulent inflammation of the portal vein or its branches.

Pathology.—If noted in the early stages, the coats of the portal vein are distended and thickened, and the connective tissue surrounding the portal area is infiltrated and the seat of minute ecchymoses. The inflammation usually originates in the smaller veins of the portal system or in the hepatic branches of the vein itself; the main trunk is attacked least often. Numerous thrombi are found obstructing the vein and its branches, which finally undergo suppuration. From these, emboli enter the circulation and are carried to all parts of the liver, forming metastatic abscesses. In advanced cases the whole organ (especially the peripheral parts) becomes infiltrated with pockets of pus, that communicate with the portal vein or its branches, and extend in some instances into the mesenteric or gastric veins. A single large abscess may be present, but multiple abscesses are the rule. The contents may be very fetid and bile

suddenly with the development of edema and ascites. The liver is rarely enlarged.

Prognosis.—This depends wholly upon the cause of the affection. Thrombi in the portal vein often give rise to a suppurative pylephlebitis, terminating in hepatic abscess; tumors are rarely accessible; whereas fibroid conditions of the liver causing cicatricial contraction are incurable. As a rule, the prognosis may be said to be guardedly unfavorable.

AFFECTIONS OF THE HEPATIC BLOOD-VESSELS

Osler records a case of *stenosis of the hepatic veins* that was associated with fibroid obliteration of the inferior vena cava, with a greatly enlarged and cirrhotic liver. Among other affections of the hepatic veins are: (a) Emboli, originating from a thrombus in the right auricle, and (b) dilatation, from stasis of the blood-current flowing to the right heart, due to enlargement of the latter.

Affections of the *hepatic arteries* are exceedingly rare, but may occur in one of the following forms: (a) *Aneurysm*.—Only 10 or 12 cases of aneurysm have been reported. (b) *Hypertrophy and Dilatation*.—These may occur in connection with general hepatic cirrhosis, the cicatricial bands obstructing the lumen of the artery, and causing thickening in some places, and ampullæ, or sac-like dilatations, in others. (c) *Sclerosis*.—This may form a part of a general arteriosclerosis, though it occurs oftener in connection with cirrhosis or syphilitic hepatitis.

ATROPHY AND HYPERTROPHY OF THE LIVER

(a) *Atrophy*.—Simple atrophy of the liver may result from pressure (corset-liver), syphilis, advanced cirrhosis, senility, and from the toxic action of phosphorus, arsenic, or chloroform—all factors that induce rapid fatty degeneration with cell destruction.

(b) *Hypertrophy* is of two kinds: (1) *true* and (2) *false*. (1) *True hypertrophy* may be subdivided into *simple* and *numerical*, the latter referring to an increase in the number of the parenchymatous cells, and not necessarily implying an increase in the size of the organ.

The two causes of simple hypertrophy are active and passive congestion. The principal causes of numerical hypertrophy are as follows: Leukemia, hypertrophic cirrhosis, atrophic cirrhosis (hyperplasia), syphilis, diabetes, and malaria.

(2) *Pseudo- or false hypertrophy* occurs in amyloid and fatty infiltration, carcinoma, and abscess, and consists in an increase in the tissues least concerned in the function of the organ.

HEPATIC INFILTRATIONS AND DEGENERATIONS

AMYLOID INFILTRATION

(*Waxy, Lardaceous, Bacony, or Albuminoid Infiltration; Amyloid Disease*)

Definition.—A deposit in the hepatic connective tissues of a peculiar substance, which was formerly held to resemble starch, but has recently been

Symptoms.—When amyloid disease occurs in *children* the subjects are poorly developed and puny, the complexion is, as a rule, muddy or sallow, and the abdomen usually prominent. Occasionally the *skin* is exceedingly transparent. At any age *gastro-intestinal symptoms* occur, prominent among which are marked constipation and a capricious appetite. *Mental phenomena*, as impairment of memory and inability to concentrate, are not unusual in this disease. *Pain* about the hepatic region is a rare symptom. The *spleen* is usually enlarged from coexistent amyloid infiltration. The *urine* often contains albumin (globulin is nearly always present), renal epithelium, and waxy tube-casts; it is of somewhat lowered specific gravity, but may be scanty and dark colored. Diarrhea, with slimy dejecta, is commonly present. The *physical signs* show an increase in the area of hepatic dulness; the edges of the organ extend below the costal margin and have a rounded outline. Sometimes, however, the edge, even in a very great enlargement, is sharp. Wilks speaks of an amyloid liver weighing 14 pounds—6.35 kgms. (Osler). In rare instances the liver is reduced in size.

Diagnosis.—The foregoing symptoms and physical signs, in conjunction with an ordinarily clear etiology (syphilis, tuberculosis, or other primary process in some other part of the body) and amyloid degeneration elsewhere, are sufficient to establish the diagnosis.

Treatment.—As amyloid disease is almost invariably a secondary condition, the treatment must be directed to the removal of the primary cause, whether syphilis, tuberculosis, or rickets. It has been shown recently that amyloid degeneration may disappear if the primary cause can be removed. The *diet* should consist of nitrogenous or animal substances, with a minimum amount of fat. French rolls and bran or gluten bread are allowable, together with lean meat, wholesome cereals, and green vegetables. Stimulants are to be strictly avoided. Moderate exercise, with the judicious use of Turkish (hot-air) and Russian (hot-vapor) baths, is also of great value.

Many drugs are mentioned in the treatment of this disease, among the more important being the ammonium salts (the chlorid, gr. v to x—0.3–0.6—three or four times a day) and other alkalies.

When syphilis has been clearly established as an etiologic factor of the disease, the tincture of iodine in 10- to 15-minim (0.6–1.0) doses, well diluted, has been recommended to be given three or four times daily. Cod-liver oil as a nutritive, if tuberculosis be associated, has been tried with good effect. Of tonics, the dilute mineral acids, given in moderate doses, have probably achieved the best results.

FATTY LIVER

The term “fatty liver” embraces (a) *fatty infiltration*, or a deposit of fat in the otherwise normal hepatic tissues, and (b) *fatty degeneration*, in which a conversion of the albuminates of the cells into fat occurs. It should be recalled, however, that the latter condition is invariably preceded and accompanied by the former, so that most instances of fatty liver partake of the nature of both processes.

FATTY INFILTRATION

Pathology.—The infiltration occurs often in localized areas, and may be so intense that the organ when cut presents a shiny, oily appearance. The liver is often evenly enlarged, and may weigh 12 to 15 pounds. The edges are rounded and the substance less firm than normally. Portions of the liver substance float in water. The color is light yellow or grayish. Microscopically, the protoplasm of the cell is seen to be pushed to one side by the

fat droplets, which tend to coalesce. Fatty infiltration may end in fatty degeneration.

Etiology.—(a) Fatty infiltration may form part of a general obesity or it may follow gastro-intestinal disorders even in childhood. (b) It often occurs in wasting diseases, as carcinoma, syphilis, chronic malaria, and tuberculosis.

Symptoms.—The subjective symptoms of fatty infiltration may be entirely wanting, since the function of the liver is not impaired to any extent. When they are present progressive *anemia* and *debility* are noted, and are accompanied by *nervous irritability* and *insomnia*. In marked cases the cardiac rhythm is disturbed, causing a *feeble and irregular impulse*.

The *physical signs* are well defined, and the area of hepatic dulness is uniformly increased, extending in some instances as low as the umbilicus. The enlargement, however, is not so great as in amyloid disease.

Differential Diagnosis.—Fatty infiltration of the liver is not apt to be mistaken for any other affection of this organ. The occurrence of general obesity, together with an entire absence of symptoms of obstruction to the portal vessels or bile-ducts or of other evidences of *fatty degeneration* (particularly feeble heart-sounds), will help to distinguish it from this latter condition. The etiologic factors above mentioned will also aid in the differentiation.

Prognosis.—This is decidedly favorable, as the function of the liver in many instances is not impaired in the slightest degree.

Treatment.—As the disease is of gradual development and long duration, a modification of the *diet* constitutes the first essential of the treatment. That prescribed under the Treatment of Amyloid Liver is admirably suited to this affection. Saccharine and farinaceous articles of food (potatoes, oatmeal, and sweetmeats) must be eschewed. Wheat bread must be partaken of sparingly, and in its place gluten and bran bread or crusts of French rolls should be used. Fish, lean meats, fresh vegetables, and fruits are also allowable. Alcoholic beverages must be interdicted. When fatty liver develops in tuberculous subjects the ingestion of fats and carbohydrates should be restricted.

Graduated daily exercise to stimulate metabolism and Turkish or Russian baths, judiciously used, are important factors in the treatment. Medicinally, the salts of the alkalies are highly recommended: sodium sulphate (in dram—4.0—doses, taken on an empty stomach) and ammonium carbonate (gr. xv to xxx—1.0–2.0—in twenty-four hours).

FATTY DEGENERATION OF THE LIVER

Pathology.—On examining a liver that is the seat of marked fatty degeneration the organ is found smaller than normally, and the substance is light yellow in color, soft, pliable, and easily torn. On section the relation between the interlobular connective tissue and the acini is lost, the latter being replaced by fat-cells and oil-droplets. Scattered areas of pigmentation may be observed throughout the organ.

Microscopically, the cells lose their shape and become globular; the nuclei tend to coalesce, and finally disappear, together with the cell wall, giving rise to compound globule-cells, which do not tend to coalesce and are stained black by osmic acid. Crystals, granular debris, Lener's spheres, cholesterin, tyrosin, and phosphatic crystals are also found in this form of granular change. His-

tologic differences are recognized at the present day between this disease and acute yellow atrophy.

Etiology.—The following are among the recognized causes of the affection: (a) The excessive use of beer or alcoholic liquors. (b) It may be a sequence of amyloid disease. (c) Diminution of the oxygen supply to the tissues, occurring in phosphorus-, chloroform-, or arsenic-poisoning, and in certain wasting diseases (carcinoma, phthisis, and chronic dysentery). (d) It may occur as a complication in the grave anemias, especially pernicious anemia, in acute infectious diseases, and the intoxications, as well as in pregnancy.

Symptoms.—I feel convinced that partial or *mild cases* of fatty degeneration of the liver present no morbid symptoms of diagnostic import. Pain, jaundice, and ascites may occur separately or conjointly, but form the exception rather than the rule. The *severe forms* are characterized by the symptoms seen in phosphorus-poisoning and acute yellow atrophy, to the discussion of which the reader is referred.

Complications.—The disease may be complicated with fatty change in the *kidneys*. Under these circumstances the *urine* is diminished in amount, of low specific gravity, and contains an abundance of albumin, fatty or oily casts, and crystals of cholesterin, leucin, and tyrosin. In marked cases there is a very *feeble* and *irregular cardiac impulse*, accompanied by attacks of *vertigo* and *syncope*, the latter symptoms indicating beginning degeneration of the cardiac muscle. *Edema* of the lower extremities and *anasarca* may occur as complications of this condition.

The **physical signs** elicited by *palpation* and *percussion* show increasing diminution in the size of the liver as the disease advances.

Diagnosis.—The chief diagnostic points of fatty degeneration may be summated thus: (a) A history of alcoholism, of poisoning by drugs (arsenic, phosphorus, or chloroform), or of an acute infectious disease (acute yellow atrophy); (b) grave general symptoms, as albuminuria, edema, ascites, cardiac failure, terminating often in acholia or cholemia; (c) progressive diminution in the size of the organ. When these occur conjointly the diagnosis is established beyond a doubt.

The **prognosis** is entirely dependent upon the curability of the cause. If due to an excessive use of stimulants, the process, if recognized early, may be arrested; if associated with an acute infectious disease, the outlook is unpromising.

Treatment.—The indications for treatment may be divided into the *dietetic*, *hygienic*, and *medicinal*. The same precautions regarding diet should be observed as in fatty infiltration. An open-air existence, short of injurious exposure, aided by hot salt-water, Turkish, or Russian baths, under restriction, is sure to improve the general condition of the patient.

The *medicinal* treatment varies according to the cause of the disease. If due to grave anemia, iron (tinct. ferri chlorid. or syrup. ferri iodid.) may be given in ascending doses. Poisoning by drugs that produce fatty degeneration of the liver is to be combated by their respective antidotes. Gastro-intestinal disturbances, if coexistent, demand appropriate treatment. For the latter **Frerichs** recommends highly the salts of the alkalies (sodium sulphate in dram—4.0—doses taken on an empty stomach and ammonium carbonate). Ascites and cardiac asthenia, when occurring as complications, must be met by suitable measures.

retracted lung. *Auscultation* reveals a *friction-sound* and an absence of breath sounds and of the vocal resonance over the dull and tympanitic areas, while the respiratory sounds over the displaced lung are bronchovesicular.

Differential Diagnosis.—Acute perihepatitis often remains unrecognized during life. It may be confounded with *empyema* of the right side, but the two conditions have different modes of development. Perihepatitis is preceded and accompanied by abdominal symptoms; empyema manifests thoracic symptoms—*e. g.*, cough and pleuritic pain. At a later stage the exaggerated respiratory murmur above the dull area, the slighter cardiac displacement toward the left, and the greater hepatic displacement downward in suppurative perihepatitis aid in the differentiation. The introduction of the trocar in the seventh or eighth intercostal space in the midaxillary line may also be helpful, especially if the exudate be found to contain bile-pigment. *Pfuhl's sign*—the more ready escape of the fluid during inspiration on aspiration of abscesses below the diaphragm—may not be without value. The points narrated above may likewise serve to separate pyopneumothorax from suppurative perihepatitis (see also Pneumothorax, p. 586). To differentiate from *acute plastic pleurisy*, Cantlie's sign, or grasping the liver between the hands and moving it backward and forward, thus causing pain running up into the supraclavicular fossa, may be employed.

Course and Prognosis.—In the milder or fibrinous variety the outlook is favorable and the course is brief. On the other hand, the suppurative type due to perforation, if not early brought under proper surgical treatment, often terminates unfavorably by gradual asthenia. Rarely the pus is resorbed, or it may find an outlet through the lungs, abdominal walls, or other avenue, followed by slow recovery.

The treatment is the same as for localized peritonitis. The first evidence of the presence of pus is the signal for surgical interference—evacuation and drainage, and Wakar¹ favors the transpleural method.

CHRONIC PERIHEPATITIS

(*Zuckergussleber*)

This affection is chronic inflammation of the perihepatic fibrous membrane, which becomes opaque and thickened. Contraction of this capsule ensues, with compression of the liver and atrophy to one-half the size of the normal organ (as in a case reported by Rumpf), and partial or total occlusion of the vessel and bile-ducts. These changes are most marked in cases that follow acute suppurative perihepatitis. Genuine instances show no hyperplasia of the interstitial connective tissue; hence the condition is closely related pathologically to "glissonian cirrhosis."

The main causes of chronic perihepatitis are great and protracted local pressure, as from a corset, and certain occupations. It may represent a portion of a more general chronic inflammation of the serosæ. I believe that syphilis is the leading single cause, and could discover no other factor present in 2 cases that yielded to antisyphilitic treatment. A circumscribed form (benign) may occur from local pressure.

The diagnosis is generally problematic. Of especial clinical worth are the etiology, pain in the right hypochondriac region—particularly in cases due to syphilis—absence of the signs of stasis of the gastro-intestinal tract, and the very protracted course.

The treatment is purely palliative, apart from the effort to remove the special cause, whether this be syphilis, occupation, or other influential factor.

¹ *Deutsch. Zeit. f. Chir.*, January, 1912.

age is 12 per cent. In general pyemic processes or in bone suppurations of long standing infection of the liver occurs. Suppurating wounds of the head may be followed by abscess of the liver. Among other causes may be mentioned *foreign bodies* traveling up the ducts, as parasites, round-worms, liver-flukes; also, more rarely, suppuerforation by mechanical irritants (needles, pins, fish-bones, and the like), and suppuration occurring in the course of a hydatid cyst. Leick has tabulated 19 cases of hepatic abscess caused by the *Ascaris lumbricoides*. Among other factors are: Age (adult life), male sex, alcoholism, and malaria.

The *manner of infection* is variable; it may be (a) through the portal vein (most commonly); (b) through the bile-ducts, and (c) the metastasis may take place through the blood (hepatic artery). (d) Exceptionally infection may occur *via* the lymph-channels.

Symptoms of Solitary Abscess.—In a typical case of hepatic abscess the most prominent symptoms are: *hectic temperature, pain, tenderness, and enlargement of the organ*, and often *slight jaundice*, although it must not be forgotten that any or all of these may be absent during its development. The multiple abscesses occurring in pyemic conditions, which are frequently diagnosed when in view upon the postmortem table, form an instance of this. The present description, however, has reference chiefly to the large, solitary abscess.

To facilitate the subject I shall consider the more important symptoms *seriatim*: *Pain* is circumscribed to the hepatic region, and radiates to the right shoulder in conjunction with the other symptoms and physical signs; it is very characteristic, although not pathognomonic of hepatic abscess. In the earlier stages this symptom is not pronounced unless the abscess or abscesses lie superficially. It is usually of a dull, boring character, differing in severity with the patient's position; it is usually aggravated by pressure over the costal margin and by lying on the left side, this tending to drag the liver by its own weight from its normal position. Luschka explains the radiation of pain to the right shoulder by stating that filaments of the phrenic nerves that distribute themselves in the suspensory ligament and Glisson's capsule are irritated. The phrenic arises from the third, fourth, and fifth cervical nerves, and as the fourth supplies sensation to the right shoulder, the impression is thus transmitted through the central nervous system.

In acute cases accompanied by rapid destruction of the hepatic tissues the *temperature* usually rises rapidly, reaching 103° or 104° F. (39.4°–40° C.) in the course of from twenty-four to thirty-six hours. Its course, however, is irregular and intermittent, and it may be hectic in character; just as often it resembles a tertian or quartan intermittent or a remittent malarial fever. *Rigors* or *decided chills* frequently accompany the rise of temperature, and during the decline profuse sweatings may take place. In chronic abscess of the liver pyrexia may be entirely absent. Less commonly the temperature may remain continuously high, with slight morning remissions. The *pulse* is usually rapid in proportion to the temperature.

The **physical signs** in a case of hepatic abscess are always present to a greater or less degree, and are often pathognomonic.

Inspection may reveal nothing during the entire course of the disease, although if there be intense congestion involving the anterior surface of the right lobe, bulging of the ribs on that side will occur, with a marked prominence in the hypochondriac region extending three or more fingerbreadths below the costal margin.

Palpation confirms inspection and reveals tenderness on pressure below the costal margin in the mammary line. The liver, if projecting below the edge of the ribs, is usually enlarged uniformly unless the abscess involves the sur-

In *empyema* there may be the history of a perforating wound of the chest, the rupture of a bronchiectatic or tuberculous cavity, or the pre-existence of a serofibrinous pleurisy; whereas hepatic abscess may be preceded by an attack of amebic dysentery, intestinal ulceration from other forms of infection, impacted gall-stones, traumatism, or a pyemic process. In both there may be the occurrence of hectic temperature, with chills and sweating; but in *empyema* cough and dyspnea are prominent, and, if the pleural cavity communicates with a bronchus, profuse mucopurulent expectoration containing pus-cells, staphylococci, streptococci, and tubercle bacilli may be observed. Rarely an abscess of the liver penetrates the diaphragm and is expectorated. The recognition of hepatic abscess under these circumstances is to be based mainly upon clear previous evidence of the affection, and copious, blood-tinted, purulent expectoration. The detection of the *Amæba coli* in the sputum alone would set the diagnosis at rest. The contents of hepatic abscess obtained by aspiration consist of the micro-organisms of suppuration, broken-down liver-cells, bile-pigment, and in some cases the *Amæba coli*. Inspection in *empyema* reveals bulging of the intercostal spaces on the side implicated, and there is movable percussion flatness over the base of the chest, rising posteriorly. On the other hand, in abscess of the liver, the lung is slightly displaced upward, being often bound to the diaphragm by adhesions; and the upper boundary of dulness is lower, particularly in front, and is immovable.

Suppurative Pylephlebitis.—In hepatic abscess there are present certain physical signs (swelling, fluctuation), and a history of amebic dysentery rather than of appendicitis, as in suppurative pylephlebitis.

HEPATIC ABSCESS

History of traumatism, dysentery, intestinal ulceration, or residence in tropical countries.

Hectic character of the temperature—high every evening and low every morning; irregular chills, followed by fevers and sweatings.

An irregular, fluctuating tumor or multiple nodules in the liver; no splenic enlargement; rapid emaciation, with or without jaundice, but no cachexia.

Blood shows simple anemia and leukocytosis, and in marked cases disintegration of red blood-cells.

Abscess contents show the staphylococci, streptococci, amebæ, or *Bacillus coli communis*, and pus.

Quinin is resisted.

MALARIA

History of previous attacks. Residence in warm, damp climates among the lowlands.

Regularly recurrent rise of the temperature (intermittent or remittent, quotidian, tertian, quartan, or septinarian), followed by profuse sweating; chills more often in morning.

The spleen is enlarged; also there is a yellowish-brown coloration of the skin, more or less marked; and, in long-standing cases, the occurrence of *cachexia*.

The presence of the hematozoa of Laveran and free pigment in the blood; usually a leukopenia.

Absent.

Quinin acts as a specific.

Impacted Calculi.—In this condition attacks of *hepatic colic* are often first noticed, followed by jaundice, and, if impaction be not absolute, by the occurrence of stones in the feces. In abscess the pain is not paroxysmal, but dull and boring in character, increasing in severity as the disease progresses. In *chronic impaction*, jaundice, dull pain over the hepatic area, distention of the gall-bladder (which in some instances may be palpated), and clay-colored feces constitute the principal symptoms. There occurs also an intermittent fever as in hepatic abscess, but it is occasional—*i. e.*, the febrile paroxysms recur at longer intervals. Again, the course of intermittent hepatic fever associated with biliary calculi is much more chronic than the fever-stage of suppurative hepatitis. On the other hand, in abscess of the liver jaundice

may be found. Findlay found the fibrous tissue to be increased and in the periphery of the lobules attempts at regeneration (proliferation of the hepatic cells). The common duct is patulous.

In well-marked cases both the *heart* and *kidneys* show evidences of fatty degeneration. The *spleen* is greatly enlarged from active congestion, giving rise to the so-called "acute splenic tumor." The splenic substance is soft and easily torn. The *skin* and *mucous membranes* may be the seat of numerous ecchymoses, and dropsy of the serous cavities is frequently noted. The *blood* is dark and fluid (disintegrated).

Etiology.—The causes of acute yellow atrophy are both primary and secondary. *Primary* or idiopathic acute yellow atrophy is rare and its etiology as yet unsettled. Among the *secondary* predisposing causes are age (being most common from fifteen to thirty-five years), female sex, mental worry, nervous shock, syphilis, chloroform anesthesia, trauma, and certain acute fevers (puerperal fever, typhoid, septicemia, malaria). The influence of pregnancy is noteworthy (30 per cent. of all cases). Acute phosphorus-poisoning sometimes presents changes resembling those of acute yellow atrophy. The disease rarely accompanies cirrhosis of the liver and may follow a debauch. Rarely an endemic form is assumed, but the exciting cause is thus far unknown. The disease is probably micro-organismal or toxic in nature, and although various germs have been discovered, their claim to specificity has not been established.

Symptoms.—The clinical history of acute yellow atrophy varies considerably in the early stages of the disease, the graver symptoms of the later stage alone being pathognomonic. The attack is usually ushered in by *headache*, *malaise*, *anorexia*, *nausea*, and *vomiting*, moderate *fever*, and after a few days *jaundice* appears. *Physical examination* at this time shows the area of hepatic dulness to be normal or only slightly increased. After a period varying from a few days to two or three weeks (during which the typical features of catarrhal jaundice have been present) grave *nervous* and *cerebral* symptoms present themselves, as restlessness and violent headache, followed by delirium, which often becomes maniacal. *Convulsions* then appear, and are succeeded by stupor and coma, the latter occurring usually within forty-eight hours from the onset of the period of cerebral excitement. Often *coarse tremors* are noticed in the voluntary muscles, and with the onset of the second stage the jaundice usually deepens.

The *temperature* often remains normal until just before death, when it may rise 1 or 2 degrees. The *pulse* is much diminished both in volume and tension, and is rapid in proportion to the temperature. The *tongue* at the onset is covered with a light coating, most marked on the dorsum and tip. Later it changes to a thick yellow color and becomes dry and fissured, with the development of a typhoid state. Vomiting appears usually during the premonitory stage and often becomes intense; the *vomit* consists at first simply of the gastric contents, which later in the disease becomes mixed with blood (hematemesis). *Hemorrhages* also occur into the skin (ecchymoses) and from the mucous membranes, giving rise to epistaxis, hematuria, melena, hemoptysis, and menorrhagia. *Constipation* with clay-colored stools is common.

The *urine* in acute yellow atrophy is often scanty in amount, high colored, and shows an increase in specific gravity (1028 to 1032). The urea is greatly diminished, but bile-pigments and albumin, tube-casts, *leucin* and *tyrosin* are found both on chemical and microscopic examination. The latter can be easily demonstrated by allowing a drop of the urine to evaporate on a cover-glass and examining under the microscope. Tyrosin crystals are deposited

in the form of sheaves and rosettes, leucin as globular masses. These bodies are not constantly present. Thus, out of 34 cases collected by Thierfelder, in which the urine was examined in this relation, "in 7 the result was negative; in 17 both were found; in 3 tyrosin only; in 7 leucin only." Among other products found in the urine worthy of mention are creatinin, lactic and sarcolactic acids, and other bodies belonging to the fatty acid series.

The **physical signs** reveal tenderness over the hepatic region, often amounting to actual pain. During the second stage, in extreme cases, the edges of the organ cannot be palpated under the costal margin. Percussion, moreover, shows a great diminution in the size of the liver, the area of dulness in a case recorded by Harley extending over but 1 inch (2.5 cm.) in the mammary line and $1\frac{1}{4}$ inches (3.1 cm.), measured perpendicularly, in the midaxillary line.

The left lobe is often the first to show physical signs of atrophy, percussion giving tympany instead of flatness in the upper epigastric region. As the atrophy continues the tympany extends below the seventh rib from above and advances upward from the costal margin, leaving but a small circumscribed area of hepatic dulness. The atrophy is usually progressive until death occurs, although favorable cases have been recorded in which the liver increased in size perceptibly during recovery.

Diagnosis.—The symptoms occurring during the second stage of the disease are usually so characteristic as to leave little doubt concerning the diagnosis. The occurrence of gradually increasing jaundice with vomiting, grave delirium, hemorrhages, the presence of an immense amount of bile, with leucin and tyrosin, in the urine, and greatly diminished size of the liver, all combine to form a typical symptom-complex. Unfortunately, leucin and tyrosin are also found in the urine in acute phosphorus-poisoning and rarely in severe acute infections.

Differential Diagnosis.—*Catarrhal jaundice* may be confused with the early stages, but a small, tender liver and pregnancy, together with careful studies of the urine (acid intoxication), should awaken strong suspicion. In *hypertrophic cirrhosis* the onset is gradual. There is generally a negative history; and an examination of the urine fails to reveal leucin and tyrosin; fever is rarely present in cirrhosis, and there is a considerable increase in the area of hepatic dulness.

The differential diagnosis between this disease and phosphorus-poisoning is given under the latter condition (*vide infra*, p. 890).

The **prognosis** is almost invariably fatal, since every case of true yellow atrophy is associated with a destruction of liver cells that is accompanied by acute toxemia.

Treatment.—As yet no specific treatment has been discovered, all remedies used being directed to the relief of symptomatic indications. The gastro-intestinal system should be relieved at the onset by divided doses of calomel. For the vomiting, cracked ice, with 1-minim (0.065) doses of the wine of ipecac repeated every half-hour, or divided doses of opium, may be given. Marked nervous phenomena with delirium I have seen controlled by cool baths and the ice-cap, together with camphor, chloral, or other anti-spasmodics used internally. The pregnant woman who develops acid intoxication and jaundice demands appropriate treatment for these conditions. Free stimulation should be begun early and persisted in throughout the course of the disease.

THE LIVER IN PHOSPHORUS-POISONING

Following the ingestion of a dose of phosphorus varying from gr. $\frac{1}{8}$ to gr. 1 (0.0008–0.065) symptoms of poisoning manifest themselves (Taylor, Wormley) as follows:

After a period of time varying from three to twelve hours a sense of wretchedness, nausea, abdominal pain (not intense), and, often, vomiting occur. The vomitus consists of the gastric contents, with bile, and during the first few hours it may contain phosphorus, which gives it a luminous appearance in the dark.

After the second or third day the vomiting usually ceases with the appearance of jaundice, which may become intense as the process continues. Later in the course of the case emesis recommences, the vomita consisting of altered blood, giving rise to the so-called "black vomit." At this stage *nervous symptoms* usually manifest themselves (headache, insomnia, vertigo, and delirium, with convulsions and coma in fatal cases), death closing the scene usually in from thirty-six to forty-eight hours.

The bowels are constipated, although attacks of diarrhea may supervene, and the evacuations are in some instances phosphorescent.

Fever is irregular and usually is not marked, the temperature swinging from 99° to 101° F. (37.2°–38.3° C.). In fatal cases the temperature may become subnormal just before death.

The urine is scanty, of high specific gravity, and contains bile, bile-acids, albumin, sarcolactic acid, and in rare cases leucin and tyrosin (Wood). Renal epithelium and free fat-globules have also been found. When occurring in pregnant women, abortion or miscarriage invariably follows.

Physical examination reveals a liver uniformly enlarged and tender on pressure. In protracted cases atrophy of the organ may rarely occur.

Etiology.—The most common causes are: (a) Occupation, workers in match factories being the most frequent sufferers; (b) the accidental swallowing of phosphorus (*e. g.*, rat-poison, friction-match heads).

Pathology.—On opening the abdominal cavity in a case of phosphorus-poisoning the liver is seen to extend below the costal margin, its surface being lighter in color than normal and mottled in appearance, and its substance softer in consistence and friable.

The cut section presents marked evidences of fatty degeneration, the acini being lighter in color than the interlobular tissue. Portions of the hepatic parenchyma are deeply bile-stained, and on scraping the cut surface bile and fat-globules will be found on the edge of the knife. The gall-bladder may be either full or empty. *Microscopically*, disintegrated liver-cells, fat-globules, granular debris, biliary coloring-matter, leucin spheres, cholesterin plates, and tyrosin needles are noted.

The gastric mucosa is found thickened, opaque, and yellowish-white in appearance, due, as pointed out by Virchow, to a universal gastro-adenitis, and not to the local action of the poison. Ulcerative or erosive gastritis is very rare in phosphorus-poisoning.

The kidneys may show beginning atrophy, the epithelium in the cortices undergoing granular and fatty degeneration, with final destruction of the cells.

The blood is dark, fluid, and not easily coagulable. Concato found that during life the white corpuscles are increased in number, and that the red are changed in shape and smaller than normal (Wood). Petechiæ and ecchymoses frequently appear in all parts of the body.

The diagnosis of acute phosphorus-poisoning is always extremely difficult and often impossible. The disease with which it is most apt to become

(a) **Portal Cirrhosis** (*Laennec's, atrophic, or alcoholic cirrhosis*) is the most common form, at least in the earliest stages, as Foxwell's studies teach; the alcoholic (indurative) liver is more commonly enlarged than decreased in size. Foxwell examined the records of 37 cases of cirrhosis, and found that among these there were 13 instances of enlarged liver, 11 of normal size, and 12 smaller than normal. In typical examples the capsule is thickened, the organ greatly reduced in size, hard, granular, and much altered in shape. On section (which tests the cutting-knife) the surface presents grayish-white bands of connective tissue surrounding yellowish areas (acini) that project above the surface on compression (hob-nails); hence the term "hob-nailed liver."

Microscopically, the process is seen to commence as an increase in the connective-tissue element surrounding the terminal branches of the portal vein. Compression of the liver cells and of the portal veins, with consequent obstruction of the circulation, constantly increases with the progress of the proliferation of the connective tissue and its secondary contraction. Atrophic changes in the hepatic cells, however, are often comparatively slight. The biliary canaliculi may be increased in number. Weigert and his disciple concluded that atrophy or degeneration of the acini is often the primary change, and that the connective-tissue production the secondary—filling the gap, so to speak. In alcoholic cirrhosis the liver is sometimes large, smooth, or slightly granular, soft rather than hard, as ordinarily the case, and presents a light yellow color (fatty cirrhosis). Histologically, this is a form of true cirrhosis, as shown by the presence of an increase in the connective tissue, with which, however, fatty infiltration of the acini is associated.

(b) **Hypertrophic Cirrhosis** (Hanot).—On examining the liver *in situ* in hypertrophic cirrhosis the various diameters of the organ are increased (the left sometimes more than the right), the lower border projecting several centimeters below the ribs. The margin of the liver is well defined, the substance firmer than normal, and it cuts with difficulty. The organ is lighter in color than in health, and presents a yellow or mottled green appearance. On treating a section with compound iodine solution (Lugol's) the color changes to that of a deep mahogany red. The acini are darker in hue than the interlobular tissue.

Microscopically, the peripheral zones of the acini are seen to be the seat of round-cell infiltration, with the formation of embryonal tissue; later, the interlobular connective tissue undergoes hyperplasia, causing obstruction of the biliary ducts with retention of bile, but the parenchyma is unchanged. New-formed bile-ducts are proliferated.

(c) **Biliary Cirrhosis**.—French writers have described "biliary cirrhosis" as opposed to a "portal cirrhosis" (atrophic). It results from obstruction of the bile-ducts; this causes retention of bile with swelling of the organ as a consequence. The action of the chemical irritants that are the result of stasis of bile starts a cirrhotic process around the small bile-ducts (reactive inflammation). The *microscopic appearances* of the organ simulate those of hypertrophic cirrhosis; but the hepatic cells are more deeply bile-stained. *Microscopically*, the first discoverable changes are spots of insular necrosis in the peripheral zones of the acini (Stengel). These are shortly replaced by proliferation of the interlobular connective tissues. The formation of new ducts and liver cells is common.

There is also a so-called glissonian cirrhosis (perihepatitis) in which the capsule of the organ is surrounded by a dense white fibrinous membrane, which contracts, reducing the size of the liver and altering its shape. This I have described elsewhere (*vide* Chronic Hepatitis, p. 881). Syphilitic cirrhosis of the organ receives special consideration (p. 385).

frequent and profuse, but are rarely fatal. Severe hemorrhages may also occur from enlarged varicose esophageal veins. The *tongue* is coated. Uneasiness and even pain may be experienced in the hepatic area. Owing to the establishment of a compensatory circulation the superficial epigastric and internal mammary veins enlarge and form about the umbilicus ("caput medusæ").

Hemorrhoids are common and are due to passive congestion of the hemorrhoidal veins. As the disease progresses the *general emaciation* becomes more marked. The face assumes a pinched expression, the tip of the nose has a purple tinge from distended veins; the eyes are sunken, the cheeks hollow, and the skin presents a sallow tint (*hepatic facies*). The failure of the compensatory circulation gives rise to *ascites*, or hydroperitoneum. The *spleen* becomes enlarged. At any stage, although generally in advanced cases, *toxemic symptoms* may develop due to some poisonous product in the blood of unknown nature: these are violent headache, followed by wild, noisy delirium, convulsions, stupor, and coma. They may occur without jaundice, and have been mistaken for uremia. With or without hemorrhages secondary anemia, more or less profound, is observed. Rogers states that leukocytosis is common.

Fever may be absent throughout the course of the disease, but is often present, and may reach 100° to 102° F. (37.7°–38.8° C.).

Examination of the *urine* shows it to be of increased specific gravity and frequently containing bile. It may be slightly albuminous, and contains casts, though out of 28 urinalyses in cases of cirrhosis Henry discovered the presence of albumin in but one. The urea elimination varies from health, probably owing to the disturbance of the urea-forming function of the liver.

The *physical examination* in a typical case of atrophic cirrhosis reveals a distention of the abdomen; there may be also an extreme enlargement of the superficial veins over the surface of the body. An icteroid tint of the skin is present in about 25 per cent. of the cases.

Palpation of the liver and spleen may be greatly interfered with by the large amount of peritoneal fluid present. On withdrawal of the latter, however, the spleen is found greatly enlarged. Palpation commonly detects hardened arteries, and W. W. Ford, in an analysis of 500 autopsies, finds that practically all the cases of beginning cirrhosis of the liver are associated with renal disease and cardiac affections.

The liver may show slight enlargement in the beginning of the disease; but it soon atrophies, and in emaciated subjects with lax abdominal walls its finely granular or nodular edge can be *felt* above the margin of the ribs. *Percussion* shows its vertical diameter, which normally extends from the sixth interspace to the costal margin, and averages about 4 inches (10 cm.), diminished, especially toward the median line. Posterior dulness begins lower than normally. It must be recollected that the liver is often enlarged in otherwise typical cases. An alcoholic hypertrophic cirrhosis without ascites (Gilbert, 1899), in which there is a marked collateral circulation in the abdominal wall, occurs, and all its symptoms are those of a bivenous hypertrophic cirrhosis.

Fatty cirrhosis, in which the organ is sometimes enlarged, may be latent and remain unrecognized or be discovered on the postmortem table. In 5 of my 6 cases the symptoms resembled those of the ordinary form. Among *complications* of this variety may be mentioned tuberculosis, pleurisy with effusion, and chronic nephritis.

(b) **Hypertrophic Cirrhosis.**—In this variety of the disease there is usually an absence of any alcoholic history, and it is apt to be met in young adults and even children (*vide* Etiology). *Moderate enlargement* of the liver may be present before any *digestive disorders* are observed. The latter may be absent,

when obstruction of the gall-ducts becomes complete, or "acute fermentative changes" are set up in the retained bile, the cases may terminate acutely (*e. g.*, in acute atrophy).

General Diagnosis.—(a) **Of Portal Cirrhosis.**—An assured diagnosis may be based on the following points: 1. A clear history of the most common causes (inebriety, male sex and middle life, rickets, diabetes, gout, malaria). 2. The combined presence of ascites, with hippocratic facies, and diminution in the size of the liver, as shown by the physical signs. 3. Absence of the characteristic features of acute disease, and the negative character of results from an examination of the heart, lungs, and kidneys. It is to be recollected that the volume of the liver is not invariably decreased, and even may be increased.

With the atrophic form of cirrhosis, *chronic peritonitis with effusion* is most liable to be confounded. In the latter disease there are characteristic abdominal tenderness, fever, and usually associated tuberculous lesions of other organs (lungs, kidneys, intestines); but the hepatic facies and clearly indicative history of atrophic cirrhosis are absent. A large peritoneal effusion is in favor of cirrhosis. Cheney recommends that the blood be examined for *syphilis*, since there may be nothing noted on physical examination or in connection with the symptoms to determine the luetic etiology.

(b) **Of Hypertrophic Cirrhosis.**—The principal diagnostic points are an absence of the usual alcoholic history, slight icterus, extending over a variable and oftentimes long period, paroxysms of pain, mucous and cutaneous hemorrhages, moderate enlargement of the liver and spleen (without ascites), and the development of grave symptoms at any stage—intense jaundice, fever, sometimes marked nervous phenomena.

Functional Tests of Hepatic Insufficiency.—In many cases of suspected liver disease, particularly the cirrhotics, the symptoms and physical signs may be suggestive of the disorder, but not sufficiently definite to make a diagnosis. Furthermore, it is often of value in prognosis to attempt to determine the functional power of the liver cells. Unfortunately, no functional test of marked clinical value has been elaborated comparable to the phthalein-test of kidney function. The liver has many functions, so that disturbance of one function does not necessarily imply disturbance of all functions. The functions of the liver are necessarily dependent upon the proper efficiency of other organs through the collaboration of which the end-results are attained; the liver has no single function that is peculiar to the organ alone or which, rather, does not depend upon many extraneous factors; furthermore, obvious disease of the liver may be associated with undisturbed function so great is the factor of safety in this large organ. It follows, then, that tests of liver sufficiency depend upon so many factors that no single test is specific, and that the estimation of hepatic insufficiency must depend upon a careful correlation of symptoms, physical findings, and laboratory tests.

Probably the most efficient test of hepatic function is that which shows the presence or absence of *urobilin* when evidence of increased blood destruction is not demonstrable. Urobilinuria is extremely common in hepatic cirrhosis and in advanced passive congestion of the liver. Acute yellow atrophy and phosphorus- and chloroform-poisoning all show it. In febrile conditions, probably as a result of cloudy swelling of the liver parenchyma, it is also present.

Alimentary levulosuria (Strauss's test) is often present in liver disease, particularly cirrhosis and catarrhal jaundice. According to Chajes, it is found in 86.9 per cent. of cases of cirrhosis of the liver. The test depends upon the fact that the action of liver is apparently necessary for properly metabolizing levulose and also galactose. To perform the test 100 grams of levulose dissolved in weak

(c) *Biliary cirrhosis* causes enlargement of the liver, but to a much more moderate extent than hypertrophic cirrhosis. In the former the symptoms of obstruction of the bile-ducts—jaundice and loss of color on the part of the stools (unlike the hypertrophic form) are in evidence. The duration of biliary cirrhosis is, on the whole, shorter than that of hypertrophic, and terminal diminution in size (atrophy) more common.

The prognosis of the atrophic form of cirrhosis is decidedly unfavorable, the function of the liver cells having been impaired, although the principal source of danger is probably the ascites; and death usually takes place within a few months or a year after symptoms of portal obstruction appear. In

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Fig. 55.—Showing approximate enlargement of the liver corresponding to the different diseases described in the text (after Rindfleisch): *I*, Position of the diaphragm to the maximum enlargement (carcinoma); *II*, *III*, normal situation of the diaphragm; *II*, *III*, relative dulness; *IV*, border of the liver in cirrhosis; *V*, border in health; *VI*, lower border of the fatty liver, *VII*, of the amyloid liver; *VIII*, of carcinoma, leukemia, and adenoma.

rare cases the symptoms abate, owing to the establishment of a compensatory circulation, and may remain in abeyance for months or years.

The prospect of life is much enhanced by an early recognition and removal of the overshadowing cause—alcoholism. I have seen a few cures made in this manner. Even after the occurrence of jaundice, hematemesis, and toxic symptoms, under appropriate treatment patients have been known to enjoy comparative health for years.

Treatment.—The *prophylactic* treatment, which is of first importance, consists in improving the general health of the patient and in removing, if possible, the cause of the affection. Rest, graduated exercise, systematic bathing, and regular hours for eating and sleeping should be inaugurated and strictly adhered to. Alcohol, strong coffee, spices, and gastro-intestinal

size and vary in shape, being hexagonal, polyhedral, or amorphous. Large giant-cells and spots of pigment known as "brownish granules" are not commonly found in the cancerous mass. The so-called colloid cancers are nearly always mucoid, and the cells have undergone a mucoid change; the stroma of connective tissue surrounding the cancer-nests in some instances undergoes hyaline or myxomatous degeneration. In other instances the interstitial trabeculae completely surround the epithelial nests, which are separated by a basement membrane; this variety is termed *adenocarcinoma*.

When examined microscopically, *medullary cancer*, either in a large mass (primary) or in secondary nodules scattered throughout the organ, is the most common variety found in the liver. On examining a liver that is the seat of carcinoma, one of two conditions usually presents itself: *First*, the organ may appear apparently normal with the exception of one lobe (usually the right), which contains a dense whitish growth of firm consistence, being distinct and sharply defined from the surrounding liver tissue. On section the tumor is of uniform density, bluish-white in appearance, and exudes a milk-white fluid known as "cancer-juice," which, when examined microscopically, is found to contain large, nucleated, and irregularly shaped cells containing free granular matter. The center of the tumor may have undergone liquefaction-necrosis, with the formation of a cyst, or it may be the seat of an abscess. Various smaller nodules may be scattered throughout the organ by metastasis from the primary growth. The *second* and most common condition is secondary carcinoma of the liver, the primary lesion being situated in the mammary glands, pylorus, or the cervix uteri. The organ is greatly enlarged, as a rule. Numerous nodules are scattered throughout, and can usually be seen projecting beneath the capsule, those superficially situated having received the name of "Karré's tubercles." In the center of these nodules characteristic pits or umbilications are often present, caused sometimes by contraction of the interstitial trabeculae and sometimes by a central softening. On section they are usually grayish-white in color and of firm consistence, although cysts, hemorrhages, pus cavities, or areas of hyaline and fatty degeneration are often found. The cells are identical with those of the primary growth, and are composed of the most part of cylindric epithelium.

In rare instances carcinoma occurs simultaneously with *cirrhosis* in the same liver, the organ presenting an uneven, nodular appearance, and being greatly increased in size and of firmer consistence than normal. When examined *in situ* the external appearance does not differ materially from that of a cirrhotic liver, but on section the whole organ is found to be infiltrated with various sized cancer-nodules surrounded by bands of cicatricial tissue. In some cases the excess of connective tissue and the amount of contraction are extreme, and the size and weight are reduced below the normal. Eggels collected 163 cases of primary hepatic carcinoma, and calls attention to the frequent association of atrophic cirrhosis and carcinoma; he regards the cirrhosis as the primary process.

Etiology.—Among the more important predisposing factors are—

(a) *Age*.—The disease is most common after thirty-five or forty years of age, although cases are not rare between twenty and thirty-five years. Descroix reports the case of a child eleven years old who died with a tumor in the right hypochondriac and iliac region, the autopsy revealing a liver studded with numerous nodules, as was demonstrated microscopically.

(b) *Sex*.—Men are more often the victims of carcinoma of the liver (primary than women. The secondary variety, however, is slightly more frequent in women, following carcinoma of the uterus or mammary gland.

On *palpation* the organ can be distinctly felt projecting below the costal margin and extending in some instances to a point below the level of the umbilicus. During respiration (forced) the liver can be felt to move downward and upward, the organ being under the influence of the diaphragmatic excursions. In emaciated subjects the cancer-nodules are readily appreciable, and in some instances the central pits or depressions are palpable, forming a characteristic sign. Cancerous infiltration of the anterior margin is most easily felt, and in enormous enlargements of the organ I have detected them on the posterior surface as well. Rarely the liver is found to be uniformly large. Palpation may also show splenic enlargement due to passive congestion.

Percussion.—In primary carcinoma (usually found in the right lobe) the percussion dulness is increased irregularly downward and generally to the right. On the other hand, in secondary growths (usually massive) the nodules are oftener distributed equally throughout the liver. In such cases the area of dulness may extend across the epigastrium to the left hypochondriac region, the heart and other viscera being now displaced. Posteriorly, dulness may extend upward on a level with the fourth rib, and anteriorly downward to the iliac fossa. The organ may now weigh from 15 to 20 pounds (6.5–9 kgms.), while in the average case the carcinomatous liver weighs from 3 to 6 pounds (1.3–2.6 kgms.).

Diagnosis.—In forming a diagnosis the family tendency, the history of primary carcinoma elsewhere in the body (stomach, colon, esophagus, pancreas, gall-bladder, uterus, mamma—Rolleston), the age, the localization of the pain in the right hypochondrium, the blood findings, the metastases, the cachexia, and the progressive enlargement of the liver, presenting umbilicated nodules, are the reliable points. The appearance of jaundice or ascites, or both, is confirmatory.

Differential Diagnosis.—Among affections of other organs that are likely to be mistaken for carcinoma of the liver may be mentioned (1) carcinoma of the *pylorus*, and (2) carcinoma of the *colon and omentum*. The chief diseases of the liver itself apt to be diagnosed as carcinoma are: (a) *Abscess*, (b) *syphilis*, (c) *benign growths* (*adenomata, angiomata*), (d) *hydatid cysts*, and (e) *hypertrophic cirrhosis*.

(1) *Carcinoma of the Pylorus.*—In carcinoma of the pylorus the physical examination frequently shows a hard nodular tumor that is most plainly outlined in the epigastric region. In a typical case, on deep inspiration, the tumor is pressed downward by the liver, but is not pulled upward by forced expiration, as in hepatic carcinoma. In many instances, however, adhesions bind the stomach firmly to the liver, which may be the seat of secondary involvement. The presence of jaundice, as well as the negative results from an examination of the gastric contents, would tend to eliminate pyloric carcinoma.

(2) *Carcinoma of the Colon and Omentum.*—Secondary carcinoma of the intestines affects most frequently the sigmoid flexure. The symptoms of intestinal obstruction arise, constipation being followed by attacks of serous diarrhea due to irritation, and later by the presence of blood in the stools. In carcinoma of the liver, on the other hand, the bile-ducts may be obstructed, causing clay-colored stools, but otherwise the dejecta are normal; the seat of the nodular enlargement and pain is located in the right hypochondrium. Jaundice and ascites are absent in carcinoma of the colon. The tumor, if palpable, in the latter condition is more movable and is less under the influence of the diaphragm. It does not give an absolutely flat percussion-note, as does hepatic carcinoma. Carcinoma of the omentum is usually secondary. The absence of small movable tumors in the umbilical, lumbar, or hypogastric regions, ranging in size from that of a pea to a walnut, aids in the elimination

of carcinoma of the omentum. As the latter affection advances the abdomen becomes distended and painful to the touch, the bowels are obstinately constipated, and the physical signs reveal the presence of an effusion which, when aspirated, is generally serous, but sometimes bloody. Microscopic examination may possibly reveal the presence of cancer-cells, though their recognition is difficult. The liver, unless primarily involved, is not enlarged, and cachexia does not usually appear until late.

From *hepatic abscess* the points of differentiation are—

CARCINOMA OF THE LIVER

There is often a history of a primary growth or chronic irritation.
Occurs usually after the age of forty.
Jaundice is rare.
Fever is absent or slight.
Cachexia is present and almost pathognomonic.
Pain is dull and boring in character, and more constant.
A nodular, umbilicated tumor or tumors may be detected.
The enlargement is downward.
The duration is a few months to one year.
Microscopic examination reveals disintegrated liver-cells, cancer-nests, and in some cases the micro-organisms of sup-puration.

HEPATIC ABSCESS

There is a history of traumatism or of intestinal ulceration, as in dysentery.
Occurs at any age.
Jaundice is sometimes present.
Hectic temperature, chills, and sweating.
Anemia may be present, but *never* *cachexia*.
Pain is sharp, lancinating, and paroxysmal.
A fluctuating tumor may sometimes be detected below the costal margin.
The enlargement usually upward.
The duration is usually a few weeks.
The microscope reveals pus, liver-cells, staphylococci and streptococci, the *Bacillus coli communis* or the *Amoeba coli*.

Benign Growths (Adenomata, Angiomata).—Occasionally growths are detected in the liver, and may occur at any age; when these are present at or about the age of forty they may be mistaken for carcinoma. The absence, however, of a primary growth in some one of the other viscera, together with the duration of the growth and the absence of cancerous cachexia, would tend to differentiate them from cancerous involvement. An examination of the blood may be of service, leukocytosis being more common in carcinoma.

The **prognosis** is invariably fatal, the disease terminating rapidly in from a few months to a year. The most rapid course is run by secondary carcinoma of the organ. In exceptional cases growths favorably situated have been removed without recurrence.

The **treatment** is, with rare exceptions, purely symptomatic. An easily digested, nutritious diet should be given, together with active stimulation to support the system. The pain may be relieved by the free use of morphia, given by the mouth or hypodermically. For the nausea and vomiting that are apt to supervene the carbonated waters, cracked ice with champagne, or repeated doses of creasote, dilute hydrocyanic acid, or wine of ipecac (2 minims—0.13—every hour until relieved) may be given. If violent delirium should occur during the later stages of the disease, cold compresses to the forehead or vertex, and bromids and chloral hydrate given in rectal enemata, may prove efficient.

OTHER NEW GROWTHS IN THE LIVER

(a) Angioma, Adenoma, and Cyst.

Occasionally benign growths occur in the liver, and often with an absence of symptoms unless their increase in size gives rise to mechanical obstruction.

One of the most common of these is angioma, which is often found in the livers of old people. Angiomata consist of tortuous and dilated capillaries in the hepatic connective tissue; they rarely attain a size larger than a crab-apple, and usually cause no symptoms. Although most common in adults, they have been known to occur in children.

Adenomata and cystomata may also occur in the liver. They are both benign growths. The former is of the tubular variety, consisting of connective-tissue nests lined with cylindric epithelial cells. Von Bergman removed a portion of a tuberosus adenoma of the liver with perfect recovery and non-recurrence of the growth. Cysts are quite rare. Lippmann, who searched the literature, found reported 3 retention cysts, 9 cystic adenomas, 1 lymph-cyst, and 3 cases that could not be classified.

(b) **Sarcoma.**

Of the many varieties of sarcomata, those occurring most commonly in the liver are the small and large round-celled and the melanotic variety, the latter often being secondary to sarcoma of the choroid coat of the eye. These grow rapidly, causing a wide-spread destruction of the liver structure, with a change in the size and shape of the organ that is often demonstrable by palpation. E. R. Axtell reports a case in which at the *postmortem* the upper two-thirds of the liver revealed an entire absence of hepatic structure, and consisted of three tumor masses. On section the tumor is seen to be of firmer consistence than the surrounding liver tissue, and presents a dark, grayish-white, striated appearance. If the growth be of the pigmented variety, patches of a deep black or of different shades of pigment may be scattered throughout the mass. Metastasis is rapid and wide-spread (lungs, kidneys, heart, skin), as is shown by the fact that other organs are invariably found involved at the time of the growth and development of the sarcoma in the liver. Melanosarcoma may, in rare instances, appear as a primary growth, and attain a considerable size, as shown by a case reported by Bramwell and Leith.

The *symptoms* are those of mechanical obstruction, and consist of gastrointestinal disturbances due to passive congestion, edema, and ascites. Anemia and emaciation may become marked late in the disease, but cachexia does not develop. The passage of an intensely dark colored urine (melanuria) has been noted in some cases. Secondary nodules may appear on the skin surface.

The *diagnosis* can often be made from the primary growth (melanosarcoma of the choroid or sarcomata of the lymphatic glands) and from the rapid development of the tumor. From *carcinoma* of the liver melanosarcoma may be distinguished by the presence of ocular symptoms, particularly blindness of one eye, by the rapid wide-spread metastasis, the melanuria, perhaps, and by the absence of a true cancerous cachexia.

The *prognosis* is absolutely fatal and the *treatment* merely palliative.

X. DISEASES OF THE SPLEEN

Diseases of the spleen are mostly secondary to other diseases, the consideration of which embraces an appropriate description of the associated splenic disorders. The intimate relation between the spleen and blood accounts for the frequency with which this organ is involved in many of the blood diseases.

Pathology.—Next to the kidneys, the spleen is the favorite seat of metastatic inflammation and *embolic infarction*. Splenitis, due to a benign embolus originating in the left side of the heart or from the aorta above the splenic arteries, is usually circumscribed to a zone of serohemorrhagic infiltration about the resultant infarct. The latter is hemorrhagic at first, and later becomes particolored or *mixed*, and is of a yellow color, owing to partial fatty degeneration; still later it may become whitish and remain as a wedge-shaped (the base being peripheral), cheesy (necrotic softening), or even calcareous mass, or as a fibrous cicatrix. Infection of the infarcts by pus micrococci leads to the development of *small abscesses*, and the trabeculae surrounding the latter may give way until finally one large pus-sac may be formed. Embolism may follow primary splenic arterial or venous thrombosis.

Perisplenitis generally follows, and sometimes with adhesions attached to adjacent hollow organs, as the stomach and colon, through which the perforating abscess may discharge its purulent contents. An unfortunate termination is the bursting of the abscess into the peritoneal cavity; a more fortunate ending results in an external opening. In acute splenic tumor there is an active congestion, with round-cell infiltration and some proliferation of the splenic cells. The spleen is moderately enlarged, dark, soft, pulpy, and friable.

In cases of intense vascular engorgement, as in the acute splenic tumor of severe typhoid fever, intermittent fever, and epilepsy (during the paroxysm), *hemorrhagic extravasation* may occur, and there may finally be even a rupture of the capsule and a passage of the blood into the peritoneal cavity. In chronic splenic tumor there is a persistent hyperplasia of the splenic cells. *Cirrhosis of the spleen* (chronic interstitial splenitis) differs characteristically from that of other organs (liver, kidneys) in that there is *enlargement instead of contraction*. Added to the increase in the size of the spleen, there are in both forms of chronic splenitis thickening of the capsule, patches often of old perisplenitis, and a slaty color of the tissues, with more or less pigmentation.

Etiology.—The disease probably never starts primarily in the spleen itself. *Acute proliferative or hyperplastic splenitis* (*acute splenic tumor*) is seen as the result of the acute infectious diseases (typhoid, typhus, relapsing, malarial fevers). *Chronic proliferative splenitis* (*chronic splenic tumor*) is due to chronic malarial infection or repeated acute attacks, to Banti's disease, chronic passive congestion of the spleen, and leukocythemia. The leukemic spleen represents a somewhat different form of chronic proliferative splenitis from the ordinary forms. *Acute suppurative splenitis* (*abscess*), either diffuse or circumscribed, is usually secondary to infectious (pyogenic) emboli, as in ulcerative endocarditis and pyemia. Again, as the result of simple valvulitis of aortic thrombosis, *embolic infarction* of the spleen may be found, which may soften and break down in abscess formation from subsequent infection. Abscess of the spleen may also follow traumatism, perforation of a gastric ulcer, and the extension of adjacent inflammation.

Symptoms.—These are indefinite or absent in most cases. Usually there is no pain or tenderness unless perisplenitis exists. Considerable enlargement of the spleen may be attended with a *sense of weight, tension, or distress* in the left hypochondrium, and perhaps by slight *dyspnea*. Any *suppurative fever* present will most probably be dissociated from the idea of abscess of the spleen provided the local signs of pus be absent. *Sudden pain* appearing in the gastric region, followed by the *vomiting of pus and blood*, in the course of an infectious disease with *splenic enlargement*, may be due to the rupture of an abscess of the spleen. *Ascites* may also be present.

The **physical examination** may reveal some bulging on inspection, and a **fluctuating tumor** may be palpated. The enlargement may be sufficient to

The *prognosis* is unfavorable, and the *treatment* does not differ from that indicated for the underlying and causative disease.

MORBID GROWTHS OF THE SPLEEN

The principal new growths are the granulomata, as tubercles and syphilitic gummata; also secondary carcinoma, melanotic sarcoma, and hydatid and other cysts. Lymphadenoma (*e. g.*, in leukemia), angioma, and fibroma may be included among tumors of the spleen.

These affections of the spleen are all of rare occurrence, and are not readily, if at all, discoverable during life. *Carcinoma* of the spleen is always secondary; it may be diagnosticated by a physical examination, showing the organ to be enlarged, with the signs of the primary carcinoma, as of the stomach. Secondary sarcoma is more common, and is recognized by an irregular enlargement and the presence of a primary tumor.

Syphilitic gummata of the spleen are often associated with amyloid degeneration and enlargement.

Gaucher's disease¹ is a type of splenomegaly due to a peculiar cell hyperplasia which is familial in character, begins in early childhood, runs an extremely chronic course, with gradual enlargement of the spleen until it reaches an enormous size, and is not associated with jaundice, ascites, nor lymphadenopathy. The blood may show changes similar to those of the early stages of Banti's disease, while the spleen after operation shows the presence of very large multinuclear phagocytic vesiculated cells.

RUPTURE OF THE SPLEEN

This may occur as the result of an intense hyperemic engorgement, both in splenitis from the rupture of an abscess and from traumatism. In the acute splenic tumor of typhoid fever, in malaria, and during an epileptic paroxysm rupture of the capsule has been known to occur on account of the extravasation of blood. The *symptoms* are usually mistaken for those of intestinal perforation with internal hemorrhage. The *treatment* is surgical, though palliative pending the surgeon's arrival.

XI. DISEASES OF THE PANCREAS

ACUTE PANCREATITIS

Three varieties of acute pancreatitis—hemorrhagic, gangrenous, suppurative—will be described, following the usual classification, but it is to be recollected that, in the majority of instances, these are indistinguishable clinically, and represent but different stages of a single disease.

HEMORRHAGIC PANCREATITIS

Pathology.—The pancreas is enlarged, usually firm, and somewhat chocolate colored. Irregular areas show the circumscribed as well as the diffused form of hemorrhagic infiltration of the interstitial fat tissue, with thrombosis of the pancreatic veins in some cases (Day). There is also an infiltra-

¹ See Brill and Mandelbaum, *Amer. Jour. Med. Sci.*, 1913, cxlvi, 863.

Diagnosis.—This is at all times difficult, since many or all of the symptoms enumerated may be present in other affections. A careful inquiry into the previous history is important. The sudden development of an intense, deep-seated pain in the epigastrium, followed by vomiting, collapse, abdominal distention, with circumscribed resistance in the epigastrium, and the presence of constipation and slight fever, point to hemorrhagic pancreatitis. The detection of free fat in the dejections and the discovery of scattered points of tenderness are significant. Cammidge's reaction is valueless where a pancreatic disorder is suspected. Other affections may give a positive response (pneumonia, appendicitis with diffuse peritonitis). Cammidge advises that the urine examination be controlled by an examination of the feces.

Differential Diagnosis.—The temperature is apt to be higher and the pain and tenderness less localized and more constant in *peritonitis*. Fecal vomiting would indicate *obstruction of the bowel*. Here also we may determine the patency of the bowel by injection or inflation. Intestinal obstruction is of comparatively rare occurrence in the epigastrium, where the pain and distention of acute pancreatitis are localized; there are likely to be present more marked and general tympany, including the flanks, and a circumscribed distention of the intestinal coils.

In *perforating gastric or duodenal ulcer* there is a history of pain after eating, hemorrhages from the digestive tract, and anemia.

Corrosive poisons may be excluded by the history of the case and by an examination of the mouth and vomitus. *Hepatic colic* must be excluded; the pain is intermittent, and referred more to the right side than in pancreatitis. There is in pancreatitis also an early collapse.

Acute gastroduodenitis is characterized by fever, by a history of injudicious eating, followed by mild inflammatory symptoms within a few hours, and by an absence of the sudden prostration and collapse so common to hemorrhagic inflammation of the pancreas.

Prognosis.—Acute hemorrhagic pancreatitis in most cases ends in death. In view of the ease with which the disease may be overlooked it is quite possible that certain cases of milder type may recover; in these the recovery has been said to follow a different affection. Osler reports a case diagnosticated as one of intestinal obstruction in which abdominal section was performed and recovery followed. Thayer and Korte have also reported cases of cure in which a celiotomy decided the diagnosis.

The **treatment** as for shock by the use of external heat and of warm saline injections, hypodermics of morphin, atropin, strychnin, and of diffusible stimulants may probably be of some avail. Early operation with a view to establishing free drainage is the important factor in the treatment (Ochsner).

SUPPURATIVE PANCREATITIS

Pathology.—The suppuration may be diffuse, with numerous small abscesses; more commonly a single abscess exists in the head or body of the pancreas, which may be enlarged and its structure extensively destroyed. The abscess may communicate with peripancreatic areas of suppuration, or it may evacuate either into various organs (duodenum, peritoneal cavity) or externally. Pylephlebitis and hepatic abscess or pyemia may follow. A disseminated fat-necrosis is sometimes found.

Etiology.—Most of the cases occur in adult males *prior* to fifty years of age. Intemperance, trauma, and dietetic errors are among the *predisposing* causes. Infection takes place through the ducts, or from extension of neigh-

CHRONIC PANCREATITIS

iology.—The pancreas is indurated from an increased development of fibrous tissue. The glandular substance may be nearly obliterated, owing to pressure upon the duct of Wirsung, pancreatic cysts may be formed. Interstitial hemorrhages and peripancreatic adhesions may be present.

In *chronic suppurative pancreatitis* there may either be small circumscript abscesses or one large pyogenic cyst.

iology.—Chronic pancreatitis may be due to several attacks of the disease or to chronic inflammation of the pancreatic duct, often secondary to duodenal catarrh. Since the distribution of inflammation often corresponds to that of the lymphatics the infection may be lymphatic, from an infected gall-bladder, rather than duct-borne. Persistent inflammation of the ductal structures may excite it. The majority of cases, however, arise from obstruction of the biliary passages; especially cholelithiasis as a result of obstruction of the ducts. The Mayos found 81 per cent. of their cases accompanied by gall-stones.

Chronic alcoholism, syphilis, tuberculosis, and trauma probably lead to the disease. The condition may be limited to a part of the organ.

Symptoms and Diagnosis.—The symptoms are hardly indicative of the disease. The symptoms of *chronic gastric catarrh*, frequently attended by *heartburn* and *large stools*, may compose the early clinical picture. Later there may be paroxysms of *deep epigastric pain*, *slight fever*, *marked anemia*, *restlessness* and *faintness*, occurring at irregular intervals. Some *ascites* may develop, due to pressure, may be observed. The detection of *free fat* in the fecal excretions (*steatorrhea*) and undigested muscle-fibers (*azotorrhea*) in the feces of diarrhea are of great semiotic importance in the interlobular form. They may best be studied after a pancreatic test-meal consisting of scraped meat 50 gm., milk 1 liter, butter 100 gm. It has been suggested that the effect of administration of the pancreatic ferments may be taken as a valuable diagnostic aid. On the other hand, the occurrence of *glycosuria* without any disturbance of digestion in the intestines (*e. g.*, *interacinar pancreatitis*) and *lipuria* would be of distinct diagnostic value. The presence of *diabetes* probably indicates an extreme degree of destruction of this gland. Walko regards the muscle-nucleus test as being of diagnostic value. Koller advises Sahli's glutoid capsule test. The most elaborate tests of pancreatic secretions may be performed by means of the Einhorn method of digesting the duodenal contents and by means of the agar-tube method he has devised for studying the ferments in the duodenal contents.

Achyilia pancreatica, absence of the pancreatic external secretions, usually associated with *achyilia gastrica*, but frequently is an end-result of *chronic pancreatitis*. It may be recognized by the accompanying *creatorrhea* and *steatorrhea*.

Pancreatic infantilism, a term suggested by Bramwell,² is characterized by retarded bodily and sexual development, chronic diarrhea, and flatulent distention of the abdomen, depending upon cessation of pancreatic secretion. It is usually a result of chronic pancreatitis.

Neurotic appearance may be associated. *Circumscribed resistance* on palpation in the pancreatic area has been noted. Evidences of hepatic cirrhosis and of chronic renal and arterial disease may be present.

¹ *Jour. Amer. Med. Assoc.*, May 19, 1915, p. 1872.

² *Edinburgh, Med. Jour.*, May, 1915.

Symptoms.—The patient may have been in apparently robust health when the attack comes on with *sudden* and *startling* gravity. The most prominent early symptom is *intense epigastric pain*, together with a sense of *constriction*. *Nausea* and *vomiting* may be associated, and the latter is usually obstinate and gives only temporary relief. *Tympanites* may also occur. There are early and constant *general evidences* of *internal bleeding*—an anxious countenance, restlessness, depression, yawning, pallor, cold sweat, a lowered surface temperature, and a small, rapid, and weak pulse. *Prostration* and *syncope* follow, and death ends the case in from half an hour to twenty-four hours. Death is caused by reflex paralysis of the heart, due either to some coincident vascular affection, or to pressure, perhaps upon the solar plexus and semilunar ganglion (Zenker).

My table includes 24 cases, exclusive of 16 reported by Fitz, in which the condition led to speedy death from shock or from compression of the solar plexus. Owing to its “idiopathic” character in many cases, and quick destruction of life, pancreatic hemorrhage assumes intense medicolegal importance. A few cases reach death more gradually.

Diagnosis.—Given the suddenly developed signs of a concealed internal hemorrhage, with pain referred distinctly to the epigastrium, and vomiting and rapid collapse, a *probable* diagnosis may be made.

Treatment.—This consists in relieving the pain and in overcoming the collapse by free stimulation. An exploratory operation is advisable.

CARCINOMA OF THE PANCREAS

Pathology.—Primary carcinoma is the more frequent variety. It is of the scirrhus form in most cases, and usually involves the head of the gland, which may attain the size of a child’s head. Not rarely the adjacent organs are found affected, either by direct or metastatic extension of the disease, or by the pressure of the growth; the liver, peritoneum, stomach, portal vessels, bile-ducts, and aorta may thus be involved. The pancreatic duct may be occluded, so as to form retention-cysts. In 1000 autopsies at the Johns Hopkins Hospital there were 5 cases of secondary carcinoma of the pancreas. Simple extension of carcinoma of the stomach or of the duodenum may involve the pancreas.

Etiology.—*Men* from forty to sixty years of age are most liable to carcinoma of the pancreas, though it has been met with in the *newborn*. Mirallié has collected 113 cases of primary carcinoma of this viscus (Fitz).

Symptoms.—These are scarcely ever sufficient to indicate the disease with certainty. There are usually a *stubborn dyspepsia*, a *progressive loss of flesh*, *anemia*, and a *dull*, or sometimes *neuralgic*, *epigastric pain*. *Nocturnal paroxysms* of pain are common, and are often accompanied by signs of *collapse*. In some cases *vomiting* and *diarrhea* are present. The *stools* may be light in color and greasy, and may contain blood. There may also be found an abundance of *undigested muscular fibers* in the stools in the absence of diarrhea; this is an incontestable proof of faulty pancreatic digestion. *Steatorrhea* is not commonly present. Among the *pressure-effects* due to carcinoma of the head of the pancreas there may be *jaundice* (pressure upon the common duct), which persists and “is associated with an enlargement of the liver and gall-bladder.” *Ascites* may appear from pressure on the portal vein. Chylous ascites, from pressure upon the thoracic duct, has been observed. The inferior vena cava may be compressed, causing *dropsy* of the lower half of the

PANCREATIC CYST

Pathology.—Pancreatic cysts may be single or multiple, and large or small. When large they develop chiefly to the left of the median line. Single cysts may grow to an enormous size, containing as much as several gallons of fluid. The contents may at first consist simply of retained pancreatic juice, but usually the liquid is dark gray or dark brown, alkaline, and hemorrhagic and albuminous. A hematoma may be converted into a serous cyst. The specific gravity is from 1010 to 1024. Atrophy of the pancreas may ensue. Examined *microscopically*, the contents reveal leukocytes, red blood-corpuscles, mucus, fatty degeneration of the epithelium, and crystals of fatty acids and cholesterol.

Etiology.—Cysts of the pancreas may be due to occlusion of the pancreatic duct or its branches by compression from within or without the gland. They may also be due to tumors, to impaction of biliary or pancreatic calculi, to cirrhosis or angular displacements of the gland, or to the obstructive swelling and extension of catarrh of the bowel (Krecke). Of 121 cases collected by Korte, 33 were traced to traumatism. Lloyd suggests that the cysts that follow abdominal injury are instances of encysted peritonitis involving the lesser omentum and that portion covering the pancreas (*pseudocysts*). Cysts of the pancreas usually occur in adults—in 66 of 116 cases in the third and fourth decades of life (Körte). Railton, however, met a case at six months of age.

Symptoms.—*Pain* may be absent, or it may occur as colicky paroxysms, referred either to the epigastrium, the left hypochondrium, or even the left shoulder. *Jaundice* and *ascites* are present in large tumors. *Vomiting*, *constipation*, or *fatty diarrhea* (rarely), with undigested proteins in the dejecta, clay-colored, pasty, and offensive stools, may be present. *Albumin* and *uric acid* may be found in the urine. *Emaciation* is not infrequent. *Intestinal hemorrhage* may occur and recur. A late and constant symptom is a *feeling of pressure* in the epigastrium. Rarely there is increased salivary secretion (pancreatic salivation). Occasionally all subjective symptoms are absent.

On **physical examination** a smooth, elastic, lobulated *tumor* is discovered in the region of the pancreas if the growth is moderate in size. Sometimes a very large cyst develops in a remarkably short space of time—i. e., in a few weeks. When very large in size fluctuation is easily elicited. It may be freely movable in the grasp and during inspiration. It usually presents between the stomach and transverse colon an area of dulness, and unless the tumor be of large size it is surrounded by tympanitic resonance of deeper tone above than below. Auscultation may reveal a murmur caused by compression of the aorta. When the cyst attains enormous dimensions the usual *mechanical pressure effects* are produced. Körte points out that cysts without any inflammatory or traumatic etiology may exist for many years or even decades.

The **diagnosis** rests on the typical physical signs—the discovery on palpation of a smooth, elastic, lobulated, or rounded tumor that is slightly movable, and on percussion of a dull area that is not continuous above with the spleen or liver dulness. Resort has been had to filling the stomach with air and the abdomen with water (after purging), and thus proving by *palpation* the deep-seated situation (behind the stomach and omentum) of the tumor. If a fluid could be obtained from the supposed cysts containing an alkaline liquid with caustic powers, it is almost certainly connected with the pancreas. A pancreatic cyst may be mistaken for an *ovarian cyst*, for *hydatid cyst* of the left lobe of the liver, of the mesentery, *renal tumors (cysts)*, *dropsy of the gall-bladder*,

and *retroperitoneal sarcoma* (*Lobstein's cancer*). The differentiation must be made by a careful study of all the points in the case.

The **prognosis** is good under proper treatment—incision and drainage. Of 31 reported cases thus treated, only 2 proved fatal.

PANCREATIC CALCULI

Pathology.—These are grayish-white, rounded concretions, consisting principally of calcium carbonate. The calculi may be as fine as dust or as large as an almond. Among their pathologic effects are fistulous communications with the colon, peritoneal cavity, and stomach; also cystic dilatation of the duct and abscess formation. Atrophy of the organ and carcinoma due to irritation of the stones may be associated.

Etiology.—Pancreatic calculi presuppose a catarrhal condition of the pancreatic duct, with retention or anomalies of the pancreatic secretion, or some form of obstruction of the duct. The condition is rare, and, unlike gall-stones, more common in males.

The **symptoms** are developed when, during the passage of the stones along the duct to the duodenum, the latter excite inflammation. In consequence, paroxysms of *pain* occur (*pancreatic colic*) that are usually attributed to gall-stones, and we are often unable to differentiate the two conditions. The *radiation* of pain along the lower left costal border to the back rather than to the right side, and possibly the *detection of free fat in the stools* or *glycosuria*, may aid markedly in the diagnosis.

The finding of characteristic *calculi* in the stools is entirely confirmatory. Minnich has reported a case in which the calculi were found in the stools. Jaundice rarely appears in pancreatic lithiasis.

The **prognosis** is mainly dependent upon the associated lesions and upon certain sequelæ—pancreatic cysts and chronic pancreatitis.

The indications for **treatment** do not differ materially from those of hepatic colic. Surgical intervention should be considered.

XII. DISEASES OF THE PERITONEUM

ACUTE PERITONITIS

Definition.—An acute inflammation of the peritoneum. The condition may be primary or secondary. Clinically, two varieties—general and circumscribed—are recognized, while, pathologically, the disease is classified according to the nature of the exudate.

Anatomic and Physiologic Peculiarities.—The surface area of the peritoneum is quite extensive, being almost equal to that of the skin. Fluids of all sorts are rapidly absorbed by the peritoneum, and thus, if they be poisonous, constitutional manifestations are speedily propagated.

Pathology.—Upon opening the abdomen in **acute generalized peritonitis** vascular injection both of the serous covering of the intestines and of the parietal layer is observed. Even in the most recent cases the coils of intestines may be feebly glued together by lymph, while in those of longer duration the adhesions are quite firm. As in the analogous inflammation of the pleura

icardium, we distinguish the following forms pathologically: (a) A *plastic* *in*ous, in which there may be also a small amount of serum present. *rofibrinous* (inflammatory ascites), chiefly characterized by considerable rinous fluid; additionally, the coagulated fibrin forms a covering for the al and visceral layers of the peritoneum. (c) *Purulent* (most frequent). mount of inflammatory exudate varies greatly, and is frequently enormous, ling 30 liters (quarts). Putrefactive decomposition of the pus may occur, ally in cases due to gangrene of the gut or to puerperal peritonitis (violent), giving rise to a thin fluid that is grayish-green in color, is sometimes ctly sanious, and ill-smelling. Offensive gases are present with relative ncy. These may come from the intestinal canal, following the track forations; or they may be due to decomposition of the purulent exudate. *hemorrhagic*.—This form is common in cases that are of a carcinomatous erculous nature, and in subjects whose vitality has been lowered by va-primary affections. It may also be of traumatic origin.

anges in the Intestines.—The effect of acute peritonitis is to thicken ats by inflammatory edema; soon the musculature is paralyzed. An ated catarrh of the mucosa of the intestines is sometimes observed.

ie different pathologic varieties above described may be limited to defi-ortions of the peritoneal sac, when they are termed “encapsulated” alized acute peritonitis (*vide supra*). In localized purulent peritonitis r extension of the process is arrested by the rapid formation of circum-d adhesions due to the exudation of lymph; there are also undoubted ces of circumscribed, aplastic peritoneal abscesses. The milder forms ited plastic and serofibrinous peritonitis pursue a slower course than arulent variety, and commonly lead to the development of firm adhesions *ive peritonitis*). Since the histologic changes in acute peritonitis do not from those observed in other inflammations of serous membranes, the r is referred to the section on Pleurisy (p. 562) for their consideration.

iology.—The irritants causing acute peritonitis may be: (a) **Bacteriologic** ts.—These may be *specific* or *non-specific*. Among the non-specific s are the pyogenic bacteria. Grawitz has shown that the latter can only peritonitis under certain conditions: they excite the disease when in- into the peritoneal cavity or when poured out from the diseased or in- membrane more rapidly than the peritoneal tissue can dispose of them; when the epithelial layer has from any cause been removed. Absorption oe interfered with, while the pyogenic micrococci continue to enter from owel or other viscera in great numbers. Unfortunately, the clinical itioner often meets with cases of peritonitis in which these pyogenic isms are the only positive agents. These essential conditions obtain the membrane is wounded by the perforation of gastric and intestinal , and also in perforation of the gall-bladder, in rupture of the liver, kidneys, pleen, when the latter are the seat of abscesses, and, with uncommon ncy, in appendicitides, in purulent inflammation of the ovaries and of illoplan tubes. “There are instances in which peritonitis has followed re of an apparently normal graafian follicle” (Osler). These perforative of peritonitis are at the same time the most serious and the most impor-

“Death may result from the injection into the peritoneal sac of putrid if the dose be large enough; but it is practically the same whether the s injected into the blood-stream at once or allowed to find its way into ritoneal cavity, and the result follows nearly as quickly in the one case the other” (Moullin). The rapid absorption of liquid substances gives pportunity for the phagocytic action of the white blood-corpuscles. nong specific organic irritants the *tubercle bacillus* deserves special men-

bodily movements. It remits, but does not intermit, though it may be slight in *asthenic (secondary)* cases. Here the patient is excessively weak, while his sensibilities are greatly blunted by the primary infection. Gastro-intestinal symptoms are prominent, more particularly *vomiting*, which occurs early and is apt to recur with comparative frequency. It may follow the taking of food, though, in my experience, it has more commonly taken place spontaneously; the *vomit* then consists of a watery liquid greenish in color and containing mucus. In rare instances it is a dark brown liquid. Vomiting may sometimes be absent, however, owing to the presence of marked *asthenia* or *coma*. *Eructations* and, later, *hiccup*, are common, and *constipation* is usually present and may become exceedingly obstinate. On the other hand, there may either be *diarrhea* throughout the disease, or this symptom may precede the constipation. It is to be ascribed to an increased peristalsis due to intestinal catarrh. Constipation is due chiefly to paralysis of the musculature of the intestine. The *apex* of the heart is elevated; the *tongue* at first is furred and moist, and later it is dry, brown, and often fissured.

Constitutional Symptoms.—At the onset the patient in *sthenic* cases is seized with a *rigor* that may be repeated. The *shock* sustained by the nervous system in acute peritonitis is most intense; the *temperature* rises immediately, though it does not, as a rule, attain a high level, and it frequently presents a curve more or less characteristic of suppuration. The rectal temperature is often relatively high; the respirations are shallow (costal) and much accelerated, ranging from 30 to 40 per minute. We have, as factors to account for this increased frequency, (a) a crowding upward of the diaphragm, (b) the greatly enfeebled heart, and (c) the pain occasioned by throwing the diaphragm into action. The *heart* becomes weak, the pulse-rate at first, however, ranging from 100 to 130, with a rise in the blood-pressure. The pulse toward the close becomes exceedingly frequent (130 to 150 beats per minute) and is almost imperceptible. Other evidences of more or less marked *circulatory collapse* soon manifest themselves. The patient wears an anxious facial expression, the eyes are sunken, the features pinched and cool, the lips cyanotic, and the extremities are likewise cold and somewhat livid. The patient invariably assumes the *supine position*, with the lower extremities drawn up, so as to lessen the tension of the abdominal muscles, and thus to secure the greatest possible comfort. The *urine* is scanty in amount, high colored, and contains indican. There may be a retention of urine; though oftener, perhaps, micturition is more frequent than in health. A polynuclear leukocytosis occurs, if we except the fulminating cases in which leukopenia may be found. Marked *nervous symptoms* do not appear; indeed, the mind usually remains quite clear to the close. Moderate delirium, however, which sometimes gives way to mild stupor, is met with occasionally. In the *asthenic form* of acute peritonitis the constitutional features differ from those described above. The *temperature* is usually subnormal (except in the rectum), the pulse is exceedingly feeble and running, and the signs of collapse are well marked from the onset.

Physical Signs.—*Inspection* reveals the gradually increasing abdominal distention, that frequently becomes excessive if the intestinal walls are more or less completely paralyzed. Often the amount of effusion soon becomes large, when the abdomen appears widened. The degree of distention bears a definite relation to the severity of the inflammatory process, and is in inverse ratio to the development of the abdominal muscles. Thus, when the latter are poorly developed or greatly relaxed the expansion is enormous. On the other hand, when they are strong the muscles are apt to be quite tense, permitting of a relatively slight enlargement; the abdomen may even show a small

LOCALIZED OR PARTIAL PERITONITIS
(*Circumscribed Peritonitis; Visceral Peritonitis*)

This is a localized form of inflammation of the peritoneum that is coextensive only with the serous covering of single organs, and involves a limited portion of the membrane. Hence, to the various forms of circumscribed peritonitis such terms as perihepatitis, perisplenitis, perinephritis are applied. The condition is found in its most important form in *appendicitis*, but the points that are characteristic of localization in this disease have been mentioned elsewhere (*vide* *Appendicitis*, p. 829). Localized peritonitis may also be caused by carcinoma.

Pyopneumothorax subphrenicus is the term applied to a circumscribed peritoneal abscess containing air, situated between the liver and diaphragm. The condition is described under the heading *Acute Perihepatitis* (p. 880).

Local pelvic peritonitis (perimetritis) is the most frequent variety, and is secondary, as a rule, to inflammation about the uterus, fallopian tubes, and ovaries. The leading causes are tuberculosis, puerperal septicemia, and gonorrhea. F. Billings points out that when abdominal rigidity is absent in this form rectal examination will disclose rigidity of the pelvic muscles.

Symptoms.—The *local* clinical features do not differ from those described under the diffuse form, but their area of distribution is more or less strictly limited to definite regions. By eliciting the *physical signs* with care fluid collections are sometimes demonstrable. The *constitutional symptoms* are likewise similar in character, though less marked than those belonging to the diffuse variety. There may be *rigors*, and *pyemic symptoms* appear, together with the temperature-curve peculiar to this condition. The danger of involvement of the general peritoneal cavity as the result either of rupture or of an extension of septic inflammation is a constant menace. When the peritonitis remains localized these cases may pursue a subacute or even a chronic course, though grave constitutional disturbance finally develops.

Diagnosis.—In attempting to diagnosticate acute generalized peritonitis it is of the utmost importance to keep in remembrance the sthenic and asthenic forms of the affection. The character and gravity of the symptoms are such as to render the diagnosis of the sthenic form entirely easy. Especially valuable local features are the *constant pain*, the *marked tympany*, the *excessive tenderness under pressure*, and the *vomiting at intervals of a greenish fluid material*. Of equal importance are general disturbances previously depicted, particularly the *cool, sharpened features* and the *ever-increasing weakness and rapidity of the pulse*. These clinical manifestations clearly foreshadow cardiac exhaustion or fatal collapse. When the cases are not seen until the advanced stage has arrived, however, the diagnosis presents many difficulties. Nothing is now more important than the consideration of the previous history, with a view to determining the point of origin and the probable cause of the disease (usually some such primary disease as *appendicitis* or *gastric ulcer*), as well as the accompanying symptoms and physical signs.

The smaller number of cases belonging to the adynamic type are from the start extremely difficult of diagnosis. Here a history that is clearly indicative, the presence of moderate tenderness, and augmented tension of the abdomen, with profound collapse, would point to this condition.

General Differential Diagnosis.—*Hysteric peritonitis* (so-called) simulates the genuine form so closely as to make the distinction an insurmountable difficulty, unless there be accompanying hysteric manifestations. Previous similar attacks point to hysteria. In my experience the tenderness has been out of proportion to the gravity of the constitutional disturbance. The patient

often complains bitterly before the abdomen has been touched; on the other hand, when his attention has been otherwise engaged, firm and prolonged pressure can be made.

Acute generalized peritonitis occasionally supervenes on *typhoid fever*. In such cases it is caused either by perforation of the intestine or by a direct extension of inflammation from a deep typhoid ulcer. If consciousness be retained, sudden severe pain, tenderness followed by excessive tympany, a peculiar indescribable *facies*, and signs of collapse will establish the diagnosis. Peritonitis, however, develops more often in those grave cases of typhoid that are attended with coma, marked meteorism, and profound adynamia, and under such conditions it often remains unrecognized (*vide* Typhoid Fever, p. 31).

In *acute enteric catarrh* the meteorism and sensitiveness under pressure are usually less pronounced; the disease also lacks the marked constitutional symptoms of acute peritonitis. The pain is colicky, is characterized by exacerbations, and even intermits in enterocolitis, while it is constant in peritonitis. The pain in acute enteric catarrh is often followed by diarrheal stools.

Intestinal colic is distinguished by the flatulence, the borborygmi, and the wandering pain in the absence of all other phenomena.

Rheumatism of the abdominal muscles excites pain, which, however, is superficially located (the disease affecting the muscular layer), and is frequently associated with rheumatism in other parts of the body. There may also be a clear history of previous rheumatic attacks.

Pleuropneumonic diseases may simulate peritonitis, since the early symptoms, especially the pain, may be referred to the abdomen. The temperature is apt to be higher and the respirations more rapid in intrathoracic affections—points that should lead to a thoracic examination.

Tubal pregnancy (after rupture) has also been confounded with acute peritonitis, but its differential diagnosis is fully discussed and must be looked for in special works on gynecology and obstetrics.

Rupture of an abdominal aneurysm and *embolism of the superior mesenteric artery* are also conditions that give rise to peritonitic symptoms—meteorism, recurrent vomiting, and violent collapse.

Acute generalized peritonitis in its symptomatology bears a close resemblance to acute intestinal obstruction, and the discriminating points have already been tabulated (*vide* p. 840).

Prognosis.—This is less grave than in the diffused form, and recovery may often be expected. Timely surgical intervention, particularly if a tendency to spreading be shown, is often helpful or may even lead to prompt recovery.

Sequelæ.—If recovery should take place, the inevitable result is the formation of adhesions and fibrous bands, the contraction of which may cause constriction of the bowels, bile-ducts, and other structures.

Treatment.—Hygienic and Dietetic.—The patient should be placed in the sitting posture in order to favor drainage into the pelvis, and should be kept absolutely undisturbed. The sick-room should be of good size and well ventilated; the temperature should be kept at from 65° to 70° F. (18.3°–21.1° C.). The diet demands careful attention. Food, as a rule, should be interdicted, as it promotes peristalsis. If it is given for any reason, but very small amounts of liquid food should be administered, such as pancreatized milk. Other liquid food-stuffs, as meat-juices and egg-white (diluted), may also be allowed. In asthenic cases alimentation must be generous, although solid articles of food are to be avoided.

Medicinal.—Surgical measures are recommended by most writers in the treatment of generalized peritonitis, although it is now generally conceded that in cases due to infection by the gonococcus and the pneumococcus noth-

ing is to be gained by immediate operation, but the formation of a localized abscess should be waited for before opening the abdomen. This is especially true of a gonococcus peritonitis. Whenever, however, there is reasonable doubt regarding the diagnosis, operation should not be delayed. Formerly the opium method of treatment, first instituted by the late Alonzo Clarke, was followed by the bulk of the profession. His plan was to administer $\frac{1}{2}$ gr. (0.0325) of morphin or its equivalent (gr. ij—0.13) of opium, and repeat the dose every second hour until the respirations were lowered to 10 or 12 per minute. The pupils were then observed to be contracted, the pulse from 76 to 80, the pain relieved, and peristalsis arrested. This latter effect was obtained, even though in the case of some patients larger doses of opium than here indicated were necessary; in others smaller doses sufficed. The bowels were absolutely let alone. It is explained that in favorable cases the bowels moved spontaneously at the end of one week, and that the patient then entered upon convalescence. This method of treatment is at present adhered to only by the ultraconservative element of the profession. Stockton advocates the opium treatment in the milder cases before the peritoneal inflammation has become generalized. The moderate use of opiates, however, results only in covering up symptoms, not in curing the patient. Stockton believes that the proper treatment of oncoming septic peritonitis is immediate operation. *Purgatives are absolutely contraindicated.* They promote peristalsis, favoring perforation and spreading infection.

In cases in which the vital forces are profoundly depressed, as shown by the symptoms of collapse and there is not even a reasonable suspicion of perforation, opium should be tried. When, however, the evidences of perforation into the general peritoneal cavity are complete and competent surgical skill is not at hand, large doses of morphin are imperative, with a view to relieving pain, keeping the patient at absolute rest, and sustaining the heart against the exhausting effect of shock. The value of serum and vaccine therapy in this disease is as yet uncertain (Fowler). For the systemic collapse and for combating thirst and vomiting I can warmly recommend *saline infusion*, preferably according to Murphy's drop method of rectal irrigation. Saline solution may also be given by hypodermoclysis or intravenous injections in order to "combat shock, relieve thirst, stimulate excretion, counteract toxemia, and restore the body fluids" (Jopson). Many surgeons simply give tap-water by the rectum, or if acidosis is feared as a result of long withdrawal of food, Crile's glucose (2 per cent.)—sodium bicarbonate (3 per cent.)—solution may be used.

Local Treatment.—The ice-bag or ice-poultices are often of distinct service in the earlier stages. Later, in localized peritonitis, blisters may be useful, although objectionable in the event of surgical intervention becoming necessary.

In order to relieve the *tympany* turpentine stupes are serviceable. I have also had favorable results from the insertion of the long rectal tube (soft esophageal) well up in the colon. Pituitary extract and eserine are reliable drugs to relieve tympany if there is no fear of promoting peristalsis, as after operation and drainage.

Pain.—No matter what general plan of treatment is pursued, the pain must be relieved by opium in some form. *Thirst* is to be relieved by chipped ice, over which a little brandy may be sprinkled, and by hypodermoclysis and proctoclysis. The *vomiting* is best treated by carbonated water exhibited in small quantities, or by iced champagne similarly administered. One-drop doses of creosote are also of value. Failing to control the vomiting by these methods is an indication for gastric lavage.

CHRONIC PERITONITIS

Definition.—Chronic inflammation of the peritoneum.

Pathology and Etiology.—The anatomic characters presented by different cases are greatly varied, though for convenience of study they may be considered under two divisions (as in the acute form): 1. *Local*. 2. *General*. The latter may be (a) **Adhesive**, when the peritoneal layers are inseparable and indistinguishable, with an obvious thickening, and the intestinal coils are everywhere seen to be grown together. The cause is usually a previous acute attack, and, doubtless, the condition is commonly produced by the *acute progressive form* (Mikulicz), which is *localized* at the start. Rheumatism is also an occasional factor, and adhesive peritonitis, confined, as a rule, to small circumscribed areas, may be engendered by the trocar used for tapping in ascites.

(b) **Proliferative Peritonitis.**—“The essential anatomic feature is great thickening of the peritoneal layers, usually without much adhesion” (Osler). It has been found to be associated with cirrhosis of the stomach, liver, and other abdominal organs. The amount of liquid effusion, varying in composition from serum to pus, is usually moderate, and it may, owing to adhesions, be loculated. The omentum is sometimes rolled up in the form of a massive cord, its long axis taking the transverse direction. In an autopsied case of chronic peritonitis apparently secondary to hepatic cirrhosis I observed in the thickened membrane numerous small hard nodules that were at the time regarded as being tuberculous in nature. It is to be pointed out, however, that a number of cases of pseudotuberculosis have been recently reported. In several of these an operative incision was followed by recovery, and this was put down as a cure of tuberculous peritonitis till the microscope showed the nodules to be fibrous. Among *etiological factors* chronic alcoholism stands first. In one case that I saw, acute followed by chronic rheumatism seemed to be the only assignable cause. The condition is sometimes secondary to chronic nephritis, to syphilis, or a general fibroid process.

(c) **Cancerous Peritonitis.**—Quite often in connection with cancerous growths in the peritoneum a well-marked peritonitis is evident. There may be a liquid exudation, which is apt to be bloody and chylous.

(d) **Chronic Tuberculous Peritonitis.**—This is the most important variety, and it may be part of a multiple serositis. The inflammatory lesions are quite pronounced, as a rule, and lead to marked thickening of the layers—changes that are to the naked eye identical in appearance with those noted under the preceding forms, but which on histologic examination show the presence of tubercles and caseous degeneration. The amount of liquid effusion varies within wide limits and is usually blood-stained. The frequent association of hepatic cirrhosis with tuberculous peritonitis should be remarked. From tuberculous peritonitis tuberculosis of the peritoneum is also to be distinguished clinically; the latter may be acute or chronic, and the lesions consist in the deposit of various sized tubercles without much collateral inflammation. Acute and chronic tuberculosis of the peritoneum have received due consideration in their appropriate place (p. 273).

(e) **“Chronic Hemorrhagic Peritonitis.”**—This term should be limited in its application to that form first described by Virchow, in which the peritoneum is at intervals partly covered by a membrane of new connective tissue that alternates, as it were, with layers of hemorrhagic extravasation. A similar condition results from the frequent use of the trocar for ascites.

Chronic Localized Peritonitis.—This is of frequent occurrence, and is confined most commonly to the serous covering of the spleen, liver, and certain portions of the bowel, particularly of the appendix. The condition results

in the formation of *firm adhesions*, with matting of the intestinal coils and fibrous bands. It is usually the *sequel* of localized acute peritonitis occurring in connection with inflammatory diseases of the different abdominal organs.

Symptoms of the General Forms.—Whether chronic peritonitis follows the acute form or not, it always develops insidiously. Most cases remain quite obscure, and not a few are totally devoid of clinical manifestations. The patient may complain of disorders of the *alimentary tract*, and especially of *constipation*. On the other hand, *diarrhea* is observed in tuberculous peritonitis from associated intestinal ulceration. Rarely pressure, from the traction force of the adhesions, on the common duct or portal vein gives rise to obstructive *jaundice*, or *ascites*, as the case may be. I saw an instance recently in which compression of the veins leading to the lower extremities caused unilateral *edema*. *Subjective abdominal sensations*, as uneasiness, oppression, heat, and pain (often colicky in character), are experienced. Sometimes pain is entirely absent.

General symptoms appear, though they are quite vague as a rule. An irregular fever, hectic in type, is occasionally observed. Later, increasing general weakness, emaciation, and general nervous disturbance become rather prominent clinical features. Some of these phenomena, however, may be due to associated affections. When the peritonitis is tuberculous we frequently see clinical evidence of the primary process in other parts of the economy (*vide* Tuberculous Peritonitis, p. 273).

Physical Signs.—*Inspection* usually shows the belly to be slightly, though unequally, enlarged. As in acute peritonitis, so here we may find the belly flat, or even concave, with great tension of its walls. Fluctuation is sometimes obtainable over limited areas only, since the fluid is not free, but encapsulated. The rolled-up and shrunken omentum may be *palpable* as a sausage-shaped transverse coil, and thick bands of adhesion may also not rarely be felt, in different places, as hard, uneven masses simulating neoplasmata. The *percussion-dulness* varies considerably with the amount of effusion, its arrangement, the degree of peritoneal thickening, as well as with the character and locality of the fibrous bands. It follows that in some cases irregular areas of tympanitic percussion-resonance and of dulness are to be found side by side. Obviously, too, changing the patient's posture would not give movable dulness, owing to sacculation of the fluid. A marked sense of resistance is experienced on percussion over the dull area. *Friction-fremitus* can sometimes be elicited, and less frequently *friction-sounds* also during forced breathing.

Symptoms of Chronic Local Peritonitis.—This condition is often entirely latent. When not so, the most characteristic indication is constant *pain*, distinctly colicky in nature and often quite intense. The *physical signs* are negative as a rule. Very rarely a resistant, ill-defined mass, corresponding with the seat of greatest pain, can be felt. A fibrous band may be so arranged as to form a snare through which a knuckle of bowel may pass, with resulting strangulation. Fitz's analysis of 295 cases of strangulation showed 63 to be caused in this way.

Differential Diagnosis.—That form of chronic peritonitis (serous or granular) most frequently seen in females at the commencement of puberty is hard to discriminate from *tuberculous peritonitis*, since the latter may be more or less latent. Tuberculous peritonitis is generally attended with fever, more pain and tenderness, and there is a more rapid accumulation of the exudate. Again, the general features, debility and loss of flesh, progress more rapidly than in granular peritonitis. The detection of conclusive evidence of the disease in persons closely related, or on physical examination of associated pulmonary tuberculosis or pleuritis, would render the diagnosis of tuberculous

blood-corpuscles (in abundance when ascites is due to general venous stasis), cells, endothelium, and cholesterin crystals. In ascites the microscopic characters of the peritoneum are usually normal, while in instances of peritonitis the membrane, including the subperitoneal fibrous tissue, is opaque and slightly thickened.

In the so-called *chylous ascites* the fluid resembles milk; it contains fat-globules, a few lymphocytes, and sugar (Hodlmoser). This condition may be associated with a collection of milky fluid in the left pleural sac, when there is thrombosis of the subclavian vein at the point at which the thoracic duct enters. The term *ascites adiposus* is applied to a milky fluid, in which the origin of the fat is the debris of degenerated epithelial cells, with few fat-droplets and no sugar (Quincke and Senator), to the exclusion of other morphologic elements.

In long-standing cases the abdominal and the thoracic organs become compressed from pressure exerted by the dropsical fluid.

Etiology.—Among the chief causal factors are those that hinder or arrest the return of venous blood from the peritoneal membrane, as the following:

(a) Pressure upon the branches of the portal vein within the liver, due to compression of surrounding tissues, as in hepatic cirrhosis (including malarial splenomegaly—De Brun), syphilis of the liver, and cancerous infiltration. (b) Various conditions in the course of which pressure may be made upon the portal vein external to the liver, as enlargement of the glands in the fissure, carcinoma, hydatids, or abscesses of the liver. Tumors of any adjacent organs (*e. g.*, pancreas) may produce it. (c) Thrombosis of the portal vein.

(d) Pressure upon the inferior vena cava after it receives the hepatic trunk (thrombosis), or upon the latter itself, or the lymphatics. (e) The portal circulation is also impeded in chronic pulmonary affections (cirrhosis and emphysema) and heart diseases (*e. g.*, ascites due to “pericarditic pseudocirrhosis of the heart”—Pick). Swelling of the liver causing increase of portal pressure is an important factor in the development of ascites of hepatic origin (Hoover).

(f) A new growth in the peritoneum may compress the smaller veins or the trunk of the mesentery. (g) Diminished resistance of the walls of the portal vessels, due to chronic affections that diminish the albuminous constituents of the blood and impair the nutrition of the peritoneum, as Bright’s disease, carcinoma, syphilis, chronic malaria, pernicious anemia, leukemia, amyloidosis. Chylous ascites is caused either by a leakage of the lacteals (due to ulceration, injuries, or the presence of filariæ) or by the obstruction of the thoracic duct (due to thrombosis, cicatrices, compression). Cases of lactescent ascites in which the fluid is milky (not chylous) have been reported. The nature of the fluid is as yet unknown. (i) Adipose ascites has for its direct cause fatty cellular degeneration, such as is found in carcinoma and tuberculosis of the peritoneum.

Symptoms.—Slight peritoneal dropsy gives rise neither to symptoms nor to abnormal physical signs. When the sac contains 1 quart (1 liter) of fluid, however, the first subjective symptoms that are due to the mechanical effect of the fluid appear. They are a sense of weight and fulness, with slight dyspnea. As the proportion of transuded serum becomes gradually increased these symptoms become more pronounced. There may, in addition, be a dragging pain in the loins, gastro-intestinal disturbance (meteorism, constipation), and dyspnea (owing to the resistance opposed to the descent of the diaphragm, resulting in compression of the lungs). The latter symptom is much increased upon exertion or on assuming the recumbent posture. Since the heart is displaced upward, an embarrassment of its action (rapidity and irregularity) would be expected. Syncope is not infrequent for similar reasons.

ASCITES

OVARIAN CYST

Clinical History

Health is bad prior to the appearance of the enlargement. History of disease of liver, lungs, heart, or other organ. Swelling begins below and gradually extends higher; more noticeable when standing than in the supine posture.

General health is good before the development of the tumor; failure afterward. Frequent history of dysmenorrhea, negative as to organic affections. Swelling is unilateral at first, gradually becoming more central.

Physical Signs

Enlargement is symmetric, the abdomen rounded and most prominent at the umbilicus; in the supine position the abdomen flattens, with lateral bulging at the umbilicus is often puffed out. Swelling is general from side to side in vertical direction. Pulsation felt. Examination often shows the tumor to be movable. A pouch may protrude into the vagina, but no cyst is felt. When standing, the upper line of dullness presents a concavity; rarely shows irregularities due to fluid running up "pockets" between coils of intestine. In the supine position the flanks are very dull with tympany in front. Percussion-dulness shifts its position with the patient. Fluid has a specific gravity of 1.014, and is usually clear. It is pale straw color.

Enlargement is asymmetric or irregular, unless the tumor be very large, when it may fill the entire abdomen. The greatest circumference is below the umbilicus, which never bulges. Fluctuation is circumscribed, corresponding to the limits of the tumor. Aortic pulsation is sometimes evident. Vaginal examination shows the uterus to be displaced. A cyst may be felt and outlined in the pelvis. When standing, the upper line of dullness is generally a convexity. In the supine position dullness is still in front and the flanks are resonant. Percussion-dulness not movable. Ovarian fluid has a specific gravity of 1.018–1.024. It is of a thick, turbid character, and the color is variable.

Ovarian cysts may also spring from the *pancreas* and *liver*; the elimination of these conditions, however, does not, as a rule, offer marked difficulty. They must be distinguished in practice from the exudation due to *chronic peritonitis*, and the points of differentiation have been arranged thus:

ASCITES

CHRONIC PERITONITIS

History of organic disease of liver, heart, kidneys, or other organ detectable. Swelling experienced. Abdomen is symmetrically enlarged. Swelling is general in the transverse and vertical directions. Percussion detects no hard masses of irregular prominence. Dulness is always movable, shifting the position of the parasternal dullness. Fluid is viscid, limpid, specific gravity of 1.014, is pale straw-yellow in color, with a greenish tinge at times. Contains 3 per cent. of albumin. Few constituents (lymphocytes, endothelial cells, erythrocytes). Freezing-point higher.

There is a previous history of acute peritonitis, tuberculosis, or inflammatory diseases of the female pelvic organs; sometimes a history of injury. Pain is a prominent symptom. Abdomen is irregularly prominent, and rarely flat. Fluctuation is often limited to circumscribed areas due to loculation of fluid. Palpation often detects resistant, uneven prominences. Dulness often not changeable on varying the position owing to adhesions. The fluid is either serofibrinous, seropurulent, or milky in nature. It is often viscid, its specific gravity is 1.018–1.024, and its color variable; 3 to 6 per cent. of albumin. Cytologic studies show more polynuclear neutrophilic leukocytes. Freezing-point lower.

NEW GROWTHS IN THE PERITONEUM

The most frequent and important of the new growths of the peritoneum are (a) carcinoma and (b) tuberculous deposit and tuberculous peritonitis, the latter two having been already considered.

CARCINOMA OF THE PERITONEUM

There occur the usual varieties—scirrhus, encephaloid, and colloid—the latter most frequently involving the omentum. Primary carcinoma of the peritoneum is rare. Primary endothelioma, however, is occasionally met with. It resembles true carcinoma in macroscopic as well as in microscopic appearances, though it is in reality to be ranked with the sarcomata on account of its origin. Carcinoma of the peritoneum is almost always secondary to carcinoma of the stomach, liver, or pelvic organs. The peritoneum may either be the seat of numerous small round miliary tumors, or, less commonly, of larger nodular masses, the most extensive development being presented by the colloid variety. Cancerous peritonitis is often found to be an associated condition, and the retroperitoneal lymph-glands may show cancerous development.

Etiology.—More cases occur in the female sex than in the male. Age has also a potent influence, most cases appearing late in life. Trauma may operate as an influential causative factor.

Symptoms.—When *primary*, carcinoma of the peritoneum is obscure during the early part of its course. Local *pain* and discomfort are complained of, and clinical evidences of the *cancerous cachexia* develop early, but these symptoms are not at first striking enough to be entirely characteristic. Later, however, the *nodules* can often be plainly felt (unless the liquid effusion be too marked), and the *ascites* (blood-stained), *loss of flesh*, *weakness*, and *anemia* are now sufficiently developed for diagnosis. In the colloid variety ascites is often absent, the abdominal cavity being the seat of a large, semisolid, non-fluctuating mass.

The *secondary form* usually follows carcinoma of the stomach or the ovaries, and the cachexia will have been developed before the peritoneum is secondarily involved in consequence of the presence of the primary growth. Hence, any symptoms referable to the general abdominal cavity are strongly suspicious. Among other *constitutional symptoms*, apart from those already mentioned, is *fever* (rarely absent), which may be due in small measure to the anemia, though in a greater measure to the associated peritonitis.

Physical Signs.—The abdomen protrudes if effusion be present or if the carcinoma be of the colloid form, though not invariably. Even when the tumor is large, dropsy of the peritoneum may make its detection impossible. On practising palpation after tapping, however, the nodules can be made out, either extending from side to side or being more or less localized and not adherent to underlying structures.

Differential Diagnosis.—It will be remembered that an oblong tumor lying transversely across the abdomen below the stomach is met in certain forms of *chronic peritonitis*. This offers the same physical signs that are presented by peritoneal carcinomata, unless the tumor masses in the latter affection be of considerable size. Carcinoma, however, is most apt to occur in persons past middle life, while nodular tuberculous peritonitis appears almost exclusively in children and young adults. Evidences of tuberculous disease elsewhere, past or present, and particularly suppuration about the umbilicus, would point to tuberculous peritonitis. Moreover, in all forms of abdominal carcinoma the inguinal glands are apt to be indurated and enlarged. Cyto-diagnosis might serve to distinguish carcinoma from tuberculosis of the peri-

PART IX

DISEASES OF THE URINARY SYSTEM

I. DISEASES OF THE KIDNEY

MOBILITY OF THE KIDNEY

(*Movable Kidney; Dislocated Kidney; Floating Kidney; Wandering Kidney; Ren Mobilis; Nephroptosis*)

Definition.—A distinction is made between two common varieties of mobile kidney, according to the degree of displacement, as follows: (1) *Movable kidney*, the upper end of which can be felt during deep inspiration, and which can be pushed down in the retroperitoneal space to the level of the umbilicus. (2) *Floating kidney*, which is freely movable below or beyond this point—*i. e.*, possessing a larger arc of mobility. In the so-called *palpable kidney* the lower edge of the organ can barely be felt on deep pressure.

Etiology.—The condition may be congenital (rare). An abnormally long renal artery may predispose to the development of a movable kidney. Emaciation with a marked wasting of the fatty capsule in which the kidney is embedded is a frequent underlying cause of movable kidney. Women are oftener affected than men, and results from multiple pregnancies, tight lacing and girdling, and traumatism (falls, heavy lifting, and the like) have frequently caused displacement and mobility of the kidney. Suckling observed that a number of girls who served beer, and were therefore obliged to stoop and immediately stand upright with considerable frequency, were likely to have movable kidney. Heavy tumors of the organ, the pressure of adjacent tumors (as of the liver), and the traction of hernias may likewise cause the condition. Watson's series of experiments proved that the structures vital to the restriction of the kidney's mobility within its normal excursion are those which form the attachments along its posterior surface and upper pole.

In *enteroptosis*, or Glénard's disease, in which there is a downward displacement of all the viscera, mobility of the kidney is often associated. Although either kidney, or even both kidneys, may be abnormally mobile, the right one is usually affected. Sometimes a floating kidney becomes fixed by peritoneal adhesions in an abnormal position, as in the right iliac fossa; an instance of this occurred in a seaman, under my care, admitted to the Medico-Chirurgical Hospital of Philadelphia.

"The body form is an important etiologic factor of movable kidney, and not only explains the greater frequency in women than in men, but also the reason why the right organ is more often displaced than the left" (Ashton). The body cavity is subdivided into three zones by two transverse planes, and

all ("splint-belly"), it may produce gastric hyperacidity, congestive appendicitis, or parenchymatous nephritis.

Floating kidney associated with Glénard's disease, in which the transverse colon, pancreas, stomach, intestines, and other viscera are prolapsed, gives rise to symptoms similar to those stated above, only with the addition of greater discomfort and nutritive and nervous disturbances. Sometimes there is albuminuria and rarely hematuria.

The *general symptoms* of movable kidney are those of neurasthenia or hysteria. Mental anxiety, leading to melancholia, sometimes follows the discovery of a movable abdominal tumor. Cephalalgia, backache, parasthesias, neuralgias, nervous dyspepsia, hypochondriasis (in men), and hysteric manifestations may arise and prove a perpetual annoyance. The condition, however, may arise in a previously neurasthenic or hysteric subject.

The *physical signs* of movable or floating kidney are highly important and diagnostic. *Palpation*, especially bimanual, as by Israel's method: the patient lying in a semirecumbent position, counterpressure (the left hand being placed over the lumbar region, the right next the skin in front, manipulating the abdomen from above downward) may detect a firm, movable tumor of renal size and shape in either flank (usually the right) just below the ribs (movable kidney), or in the inguinal or umbilical regions (floating kidney). If the patient may stand and, grasping the back of a chair, may lean slightly forward, while the examiner, at the patient's side, presses with one hand over the loin, and with the other feels over the abdomen below the ribs. Though comparatively easy to outline, the tumor is nevertheless hard to grasp; it is firm, however, readily pushed into place. Deep breathing may affect a palpable or movable kidney, but has no effect upon one that freely wanders about the abdomen (floating kidney). Pulsation of the renal artery may be felt in the last-named cases.

Inspection and *percussion* of the lumbar region in movable kidney are uncertain, and therefore unreliable. Visible depression here is rarer than a palpable tumor anteriorly. I have noted increased tympany over the affected side as compared with the opposite side.

A *diagnosis* is possible only after a careful and thorough physical examination. When this is made, an abnormally mobile kidney is usually discovered without difficulty. The size and shape of the organ, its right-sided position, and its mobility, associated with a train of local, reflex, or general nervous disturbances, especially in a thin, emaciated woman, are quite distinctive. The knee-elbow posture is sometimes more favorable than the recumbent position for determining a movable kidney.

Differential Diagnosis.—Floating kidney is, of course, more easily distinguished than the movable type, and partly because of the fact that in instances of the latter *tumors of the gall-bladder* especially and *wandering spleen* must first be excluded. The absence of a well-defined splenic notch, the presence of pulsation of the renal artery, a tympanitic note over the usually intervening colon, and an unchanged area of splenic dulness will assist in the diagnosis; in addition, there is the fact that wandering spleen is a comparatively rare affection.

Tumors of the gall-bladder are frequently mistaken for movable kidney; occasionally the opposite error is made; sometimes both conditions may exist. They are both common to women; they both may present as tumors in the right hypochondriac and umbilical regions; they are more or less movable, firm, smooth, slightly tender, round or oval in shape, with variable percussion-sounds and dyspeptic symptoms; and either may give rise to paroxysms of severe colic or to jaundice. Jaundice, however, is rare in movable kidney, while

CIRCULATORY DISORDERS OF THE KIDNEYS

ACTIVE HYPEREMIA

(Acute or Active Congestion)

Definition.—An acute, temporary engorgement of the vessels of the kidney, with little or no exudation.

Pathology.—The kidney is swollen, deep red in color, and engorged with blood, which flows freely on section. *Microscopically*, there may be seen a swelling of the cortical epithelium.

Causes.—Acute renal congestion is due mainly to the action of irritants present in the circulation, as in the acute infectious (especially the eruptive) fevers. The stimulating diuretics and certain poisonous drugs, as copaiba, cantharides, potassium chlorate, and carbolic acid, also sudden constriction of the peripheral blood-vessels by exposure to cold while the body is heated, act as causes. Postoperative acute hyperemia (ether?) is frequently met with. When prolonged the congestion passes into an acute nephritis; it may be caused in one kidney as a result of either nephrectomy of its opposite or blocking of the ureter by a calculus, clot, etc., of the opposite side.

Symptoms.—There may be a dull pain in the lumbar region, with a slight elevation of the temperature and pulse-rate. The *urine* either is scanty, as in cantharides-poisoning, it may be altogether suppressed. It is dark, its specific gravity is increased and it contains some free blood, a trace of pus, and a few hyaline tube-casts.

Prognosis.—The absence of a marked quantity of albumin, of the numerous casts, of dropsy, and of uremic symptoms distinguishes passive hyperemia from *acute nephritis*.

Prognosis. is quite favorable upon the removal of the cause. A repetition of the attacks, however, may lead to a nephritis.

Treatment.—Absolute rest and a liquid diet should be ordered. Cupping the loins or the use of hot fomentations should be practised. The free use of water and other diluents or mucilaginous drinks should be encouraged. Laxatives to freely open the bowels, and the use of hot air or a hot pack to promote sweating are important aids in relieving the congested kidneys.

PASSIVE HYPEREMIA

(Chronic or Passive Congestion)

Definition.—A chronic venous engorgement of the renal vessels, generally secondary to diseases of certain other viscera.

Pathology.—There is in the later stages a characteristic condition of the kidney called "cyanotic induration." Earlier in the case the organs are enlarged, firm, and of a dark, bluish-red color. The capsule is usually non-adherent. On section the medullary substance is seen to be darker red than the cortex and coarsely fibrous in appearance. Microscopic examination shows the capillaries (both glomerular and medullary) somewhat dilated and their walls thickened. The epithelium may either be unchanged or a little swollen, or, later, even fatty; the interstitial tissue may be slightly increased.

Causes.—Most commonly the renal congestion is a part of a general engorgement due to chronic cardiac, pulmonary, or hepatic disease. It is found in mitral valvular disease with ruptured compensation of the heart (congestive heart failure); in pulmonary emphysema, fibroid phthisis, and chronic adhesive pleurisy; and in cirrhosis of the liver. Less frequent causes of congested kidneys are tumors, the pregnant uterus, and ascites, all of which bring about

(4) *Essential Hematuria*.—Senator describes a form of hematuria that is sometimes seen in young persons whose health may be quite fair, the blood often appearing paroxysmally and without apparent cause ("renal hemophilia"). The view is gaining ground, with added experience, that so-called symptomless bleeding from the kidney is usually due to localized disease in the cortex. Payne and McInde¹ have shown that hematuria may be caused by the rupture of varicosities of the papillæ, the result of infection in and about the straight tubules, leading to scar tissue formation and secondary congestion. Obscure cases may be occasioned by latent purpura (Fonio). There is an idiopathic (family) or congenital hematuria.

(5) *Endemic hematuria* is that variety found in some of the tropical regions where the *Distoma hæmatobium* (a trematode worm) abounds.

Diagnosis.—This has for its object the discovery (1) of blood in the urine, and (2) of the source of the hemorrhage. Bloody urine varies in color according to the quantity of blood present, to its condition (coagulability), disposition, and the length of time present in the urine. A light reddish tinge or "smoky" hue may indicate a slight quantity of blood. A dark coagulum may be at the bottom as a sediment, with small clots floating above in a deep red, turbid layer, above which, again, the urine may show but the slightest tint of red. *Microscopically*, the blood-corpuscles are readily discovered, establishing the diagnosis from hemoglobinuria, in which condition they are absent.² When red corpuscles are associated with tube-casts, renal hemorrhage may be positively diagnosed. In ammoniacal urine the corpuscles are very pale and shadowy (dissolved hemoglobin). After remaining in ordinary acid and diluted urine they lose their disk-like shape and swell into spheres of a smaller diameter. Urine containing blood always shows the presence of albumin. According to Newman a ratio of albumin to hemoglobin in excess of 1 to 1.6 indicates not only an independent albuminuria but also a renal affection as the cause of the hematuria.

Chemically, the blood-pigment may be detected by Heller's test, which consists in adding liquor potassæ, boiling the urine, and observing the flakes of precipitating phosphates, which become reddish-yellow or brown from the added hemochromogen. The guaiacum test is also used. The spectroscope is sometimes employed to discover the bands of alkaline hematin in the precipitate which is conclusive. Leede recommends the accumulation of as many erythrocytes as possible by filtering a large amount of urine and applying the guaiac, or other chemical, tests to the residue left on the filter.

The *source of the blood* is of great diagnostic and therapeutic importance. In *renal hemorrhage* the blood is thoroughly mixed with the urine, giving a uniformly red, "smoky," or brown color (due to methemoglobin), as in hemorrhagic nephritis. Blood-casts and leukocytes may also be found. The disease causing hematuria may be traced sometimes by a study of the urine; thus, in valvular cardiac disease the sudden appearance of hematuria would indicate *infarction* of the kidney. The discovery of a few red blood-corpuscles in a concentrated urine would point to renal congestion. In profuse renal hemorrhages clots representing molds of the renal pelves and of the ureters may be discharged. Hemorrhage due to *calculus* is usually small in amount and appears at more or less prolonged intervals. Tuberculous hemorrhages may occur. Blood from the ureters is usually molded in clots in the shape of curved cylinders, and appears like small dark worms in the urine. Casts from the ureters are often secondary to hemorrhages; in such cases the hematuria may alternate

¹ *Jour. Amer. Med. Assoc.*, 1916, lxvii, 918.

² Hutchinson and Rainy, *Clinical Methods*, p. 337, point out a source of fallacy: "In alkaline urines, especially if they have stood for some time, the red cells are apt to swell up and disappear."

with the passage of clear urine, owing to temporary hemorrhages or to the blocking of the ureter on the diseased side. (See also Fibrinuria.)

Vesical hemorrhages may be copious. The blood and urine are not intimately mixed, and large clots settle on standing. The first portions of urine discharged may not be bloody, while the last may consist of pure blood.

Urethral blood is discharged before the urine, and either comes away freely or may be "milked out" independently of urination.

The endoscope has been used successfully to determine the source of the hemorrhage (which kidney?). It is especially useful in women.

Prognosis.—This varies with the primary source of the hematuria.

The **treatment** consists primarily in rest in bed. If the hemorrhage is an evidence of the blood dyscrasie, then measures to control hemorrhage as recounted in the section on Purpura are indicated. The treatment of hematuria, otherwise, is that of the causative condition.

HEMOGLOBINURIA

Definition.—The presence of blood-pigments in the urine.

Etiology.—The direct cause of hemoglobinuria is a condition of the blood in which, as a result of increased destruction of the red cells, the hemoglobin of the plasma reaches an amount sufficient to be excreted by the kidney.

(1) The **causes of the hemolysis** are principally *toxic*, and include the following: (a) Poisons (carbolic and pyrogallie acids, snake-venom, potassium chlorate, naphthol, phosphorus, arseniuretted hydrogen, carbon dioxide, lipoidal solvents, as ether or chloroform). (b) The ingestion of poisonous fungi or of tainted edible mushrooms (*Helvella esculenta*). (c) In some diseases it may be due to the action of hemolytic bacteria. It occurs in scurvy, purpura, and such diseases as an evidence of the increased blood destruction. Syphilitic infection may cause it (paroxysmal often). It is one of the manifestations of congenital hemolytic jaundice. (d) Extensive burns, the absorption of hemorrhagic effusions, and the transfusion of blood of a species differing from the donor, or at times from transfusion of blood from one individual to another when the blood of the former contains isohemolysins. (e) Rarely it may be due to exposure to cold and to violent physical exertion. (f) The so-called *epidemic hemoglobinuria* (Winckel's disease) occurring in the newborn.

(2) **Paroxysmal hemoglobinuria**, a rare variety, may occur without any apparent cause in persons enjoying otherwise good health, but usually following exposure to cold with subsequent warming. Donath and Landsteiner have shown that the disease is due to the presence of an autohemolysin which is activated by cooling to combine with the erythrocyte, and later, upon warming, to destroy the red cells. Thus, placing the hand of a susceptible individual in ice-water and then warming it is followed by hemoglobin excretion. The paroxysms are usually symptomless and of short duration.

(3) It appears as a symptom of *malaria* in the southern part of this country. This is termed *malignant malarial hemoglobinuria* or *hemoglobinuric fever*. In Africa it is called *black-water fever*.

Symptoms.—These are generally the symptoms of the condition that accompanies hemoglobinuria. In paroxysmal hemoglobinuria the attacks are usually sudden, brief in duration, and sometimes *intermittent*, especially when of malarial origin. An anemic condition seems to be essential to the production of malarial hemoglobinuria. *Jaundice* may be an associated symptom. The hemoglobinuria seldom lasts for more than two days, though very grave cases take on the aspect of a pernicious malarial attack. There may be lumbar pains, chills and fever, and gastric disturbances. *Urticaria* and *purpura*

have also been noted, as has anemia in cases in which frequent attacks have taken place.

Diagnosis.—This is made by an examination of the urine. Macroscopically, it is of a red-brown color, slightly turbid, with a reddish-brown or brownish-black sediment. The reaction is usually acid and the specific gravity slightly lowered. The microscopic features that distinguish hemoglobinuria from hematuria are variable. In the former condition few or no red corpuscles are present, and the few that may be seen are usually colorless ("shadows") or fragmentary. Small flakes or granules of disintegrated hemoglobin are found and are brownish-black in color. There may be also brown-tinged casts and epithelium. Chemically, the urine is found to contain albumin, for the discovery of which Heller's and the guaiac or benzdin tests for blood-pigment may be tried. The former has been described in the preceding discussion of Hematuria. By means of the spectroscope the three absorption bands of methemoglobin may be seen (red, green, and yellow). The blood-serum in hemoglobinuria may be somewhat red-tinged on account of the dissolved hemoglobin. The hemoglobinuria is further marked by the aplasticity of the red corpuscles, by their pallor, by poikilocytosis, and by the presence of the irregular flakes of hemoglobin.

The **prognosis** is favorable in the ordinary paroxysmal form. Malignant malarial hemoglobinuria, however, is often fatal.

Treatment.—Hemoglobinuria is rather intractable. During the paroxysms external warmth is needed, along with hot drinks to encourage perspiration. In malarial cases quinin, and in syphilitic, the iodids, should be administered; although by some it is believed that quinin may aggravate the syndrome in particular cases.

ALBUMINURIA

Definition.—The presence of albumin in the urine.

Pathology and Etiology.—The immediate cause is the escape of the normal blood constituents, serum-albumin and serum-globulin, from the vessels into the renal tubules. This transudation of albumin indicates either a transient and slight or a permanent and grave nutritional disturbance of either the epithelium lining the glomeruli or of that of the contained tufts of capillaries, or, possibly, of the *membrana propria* or the epithelium of the uriniferous tubules. These changes induce and offer an abnormal perviousness to the albumin of the blood.

The principal *causes* of albuminuria are: (1) Those associated with definite lesions of the kidney; nephritic, acute and chronic; renal congestions, active and passive (the latter being secondary to chronic liver, heart, and lung diseases, pregnancy, or tumors).

Albuminuria occurs also in conditions in which (2) the renal lesions are either slight or undemonstrable: (a) Thus, it is present in blood-changes, as in scurvy, purpura, syphilis, leukemia, or extreme anemia, and in cases in which urobilin or bile-pigment and sugar (glucose) circulate in the blood. Again, slight albuminuria may be present in saccharin diabetes and after etherization. In certain affections of the *nervous system* albumin is found in small quantity, as after an epileptic paroxysm, in tetanus, apoplexy, and exophthalmic goiter.

(b) The so-called *accidental* or *spurious* albuminuria is due to the presence of pus or blood; in such cases the condition is not a true renal albuminuria, since it is commonly associated with cystitis, pyelitis, urethritis, or is the result of hemorrhage from the pelvis of the kidney, from the ureters, bladder, or urethra. Chemical injury of the bladder may cause a reflex albuminuria (Evans, Wynne, and Whipple).

(c) *Febrile* albuminuria is of rather frequent occurrence in diseases accom-

panied by pyrexia, especially when long continued. Among these are typhoid fever, small-pox, yellow fever, diphtheria, and even influenza, follicular tonsillitis, and pneumonitis. The renal changes in these cases are, I believe, merely a transitory cloudy swelling in the glomeruli, which, together with the albuminuria, rarely lasts longer than the fever.

(d) Other forms of albuminuria have been styled *physiologic* or *functional*, *transient*, *dietetic*, *neurotic*, *intermittent*, and *cyclic*: in these no definite lesions of the kidney are found, and are denied by some to exist. Recent observers are inclined to believe that trivial, non-progressive renal changes occur in these cases. Slight albuminuria certainly does occur in some cases after a heavy meal rich in albumin, after marked and prolonged muscular exertion (Barach¹), intense emotion, and cold bathing.

Physiologic, functional albuminuria has come to be of greater interest and importance in later years, particularly as it bears upon the prognosis and upon life-insurance risks. In this variety there are a periodic appearance and absence of albumin in the urine. The albuminuric paroxysms are very variable, recurring usually after meals or on exertion. The albumin is present in but small quantity, and only rarely are casts (hyaline) found. The accompanying signs and symptoms common to nephritis are absent. Orthostatic or cyclic albuminuria is the most frequent of the different types of physiologic albuminuria. The urine is albumin-free as long as the patient is flat on the back. The assuming of the upright position is followed by the appearance of albumin. Thus, the urine voided the first thing in the morning has no albumin in it; about noon it is found in greatest amounts. Under careful management these cases ordinarily recover. However, an insidious degeneration of kidney structure may manifest itself many years later. Patients suffering from this type of albuminuria are usually delicate and slender. Jehle has shown that such patients, usually adolescents, have a marked lordosis, the control of which usually relieves the condition. Albuminuria may rarely be hereditary (Renault²). Slight *senile albuminuria*, without evidence of renal disease, is not uncommon.

Diagnosis.—This rests upon the discovery of albumin in the urine. For the diagnosis of cyclic albuminuria, specimens of urine passed at different times of the day must be examined.

Differential Diagnosis.—Inquiry and careful inference concerning the etiology of a given case must be made. *Renal albuminuria* is persistent and of considerable quantity except in chronic interstitial nephritis. Tube-casts are usually present. *Functional albuminuria* is slight and inconstant. Tube-casts are absent in the latter. Again, in the former variety general symptoms, as dropsy, cardiac hypertrophy, anemia, and uremic prodromes, are present. It is true that slight edema is sometimes found in cyclic albuminuria, but this is probably due to the marked anemia that is so often seen. Gleet and leukorrhea must also be excluded.

Test for Albumin.—A specimen from the well-mixed total quantity voided in twenty-four hours should be examined for albumin. The smallest quantity can be detected only by its coagulum rendering the urine turbid: hence any turbidity present before the given test is made should be removed by filtration, unless this turbidity be due to urates, when a little warming of the tube will render the urine clear.

Selling's Test.—This is the commonest and, I think, the most reliable chemical test for albumin. The tube is filled about two-thirds full of urine. If alkaline or neutral in reaction, a drop of acetic or nitric acid is added: an excess of acid must be carefully avoided, lest the albumin (if present) be converted into a non-magnifiable form. The tube, held astant, is then applied

be flame, and slowly revolved with the fingers, so that the upper portion of the column of urine is brought to the boiling-point. A comparison of this with the lower portion of the urine is made. Any turbidity is due to albumin phosphates. If albumin, adding a few drops of nitric acid or 30 per cent. nitric acid will increase and thicken the coagulum; if phosphate, the opaqueness will be cleared at once.

2) *Heller's Nitric Acid Test*.—This is both delicate and satisfactory. Put 1 c.c. of nitric acid in a tube, and some urine is allowed to flow slowly from a pipet and settle upon the acid. The presence of albumin is indicated by a white ring at the point of contact of the two liquids. Uric acid, urates, and certain urinary coloring-matters form a pink or deep red zone; this forms, as a rule, above the juncture of the acid and urine. Albumose also gives a white zone, but does not respond to the boiling test as serum-albumin.

Boston's Pipet Method.¹—"Reagents: (1) concentrated nitric acid, or nitric acid 1 part and saturated solution of magnesium sulphate 9 parts. Albumin causes a white cloud to appear in the form of a ring at the zone of contact of the two liquids (reagents and urine), and this test, when carefully tried, must be regarded as one of great value.

1. A pipet is filled for a distance of from 1 to 1½ inches with the urine to be tested. The urine is then removed from the surface of the pipet by washing with water by wiping.

2. The pipet, with its contained urine, is then placed near the bottom of a bottle containing nitric acid, when the pressure of the index-finger is lessened the acid is allowed to flow gradually up into the pipet.

3. When the pipet is seen to contain about equal amounts of acid and urine, the finger is again pressed firmly upon the top of the pipet, which is then removed from the bottle and held toward the light on a level with the surface of the acid.

If albumin is present, a distinct white ring of coagulated albumin appears at the junction of the urine and the reagent."

3) *Johnson's Picric Acid Test*.—To filtered urine in a test-tube are slowly added a few drops of a saturated watery solution of picric acid. Immediate turbidity indicates albumin. Some authorities prefer that 1 or 2 drams (8.0) of the yellow fluid be placed gently on the surface of the urine, when, if albumin is present, a white zone at once is apparent, together with a haziness which spreads downward with the diffusion of the liquids. Heating emphasizes the evidence of the test, which is extremely sensitive.

4) *Roberts' nitric magnesium test* is also very delicate. It consists in using the following mixture, just as in Heller's test: 1 volume of concentrated nitric acid added to 5 volumes of a saturated solution of magnesium sulphate.

5) *Trichloroacetic Acid Test*.—This will discover minute traces of albumin, with the disadvantage that it responds to nucleo-albumin as well as to serum-albumin. A few crystals may be dropped into the urine, or a saturated solution may be used after the "contact method," when, if albumin be present, a white coagulum forms. This and the Geisler test-papers (Vierordt) constitute reliable and handy tests.

6) The *acetic acid and potassium ferrocyanid test* is minutely sensitive, gives a precipitate with other albuminoid bodies. The urine is first diluted with acetic acid. A few drops of a freshly prepared solution of potassium ferrocyanid are then added, and if either albumin or albumose be present, it will be precipitated.

7) *Quantitative Test*.—The twenty-four-hour urine must be collected and measured and not less than 200 c.c. (about 7 ounces) examined; if forwarded to a laboratory, a note of the total must be appended. *Esbach's Albumin-*

¹ *Medical Diagnosis*, 2d ed., Anders and Boston, p. 645

ometer.—This consists in using a graduated test-tube, into which definite amounts of urine and a reagent composed of 10 parts of picric acid, 20 of citric acid, and enough water to make 1000 parts are carefully mixed by reversing several times the stoppered tube. After allowing this to stand about twenty-four hours, the height of the precipitated albumin is read off on an etched scale, which will indicate approximately the parts per thousand. Not less than 0.5 part per thousand can be estimated correctly, however. Tsuchiya has suggested the use of a solution of phosphotungstic acid as follows: Phosphotungstic acid, 1.59 grams; hydrochloric acid (conct.), 5 c.c.; ethyl alcohol, q. s. ad 100 c.c. This solution is substituted for the picric acid solution, and is used in Esbach tubes. Should there be a hematuria, if the percentage of albumin by Esbach's method, divided into the number of red cells per cubic centimeter of urine, is less than 30,000, it suggests a purely hematuric albuminuria; if greater, it suggests an independent albuminuria (Goldberg).

Prognosis.—Etiologic considerations bear heavily in this matter. The febrile, hemic, cyclic, and paroxysmal varieties usually clear up with convalescence and with advancing years (in the latter case). The persistence of albumin in these cases, however, even in slight amounts or at variable periods, should cause suspicion. Personal observation leads me to believe that in many cases the function of the renal epithelium has suffered. Especially is this true when there is associated a gradually increasing arterial tension. The presence of tube-casts is conclusive of structural change in the kidneys.

ALBUMOSURIA

Albumose may appear in the urine as a result of pathologic conditions, especially myeloma, and is dependent upon the decomposition of organized proteins. It is a body more or less closely allied to peptones, globin, histon, and the digestion albumoses, but it displays certain characteristics unknown to these substances. The nature of the *exciting cause* is unknown.

Anders and Boston have reviewed all the cases of albumosuria available in the literature up to 1903—30 in number—and gave an account of 3 examples that fell under their observation. These studies appear to warrant the following inferences: Nearly all cases of albumosuria manifest themselves after forty years of age. Males are affected in 80 per cent. of the cases. Multiple myeloma figured in 80 per cent., hence albumosuria is suggestive of myeloma and may be diagnostic.

Symptoms.—Albumosuria may be persistent, transitory, or, less commonly, remittent, and it occurs in variable degrees at different hours during the day. The urine may show the presence of combined serum-albumin, but tube-casts are present in rare instances only. Pain is an almost constant feature and is aggravated on pressure over the affected bones. Of interest is the albumosuria of pneumonia, in view of the recent theory that resolution in this disease is the result of the action of certain ferments. Other forms of albumosuria include the *enterogenic form*, noted in various intestinal diseases; the *hemotogenic form*, seen in scurvy, pregnancy, dermatitis, and so on; the *residual form*, due to proteolytic ferments in decomposing albuminous urines; a *septic form*, observed in suppurative conditions and other disorders associated with a leukocytic increase; a *digestive form*, following ingestion of albumoses in large quantities. Urines are tested for albumoses by acidifying with acetic acid, and adding an equal amount of saturated salt solution. A precipitate occurs, if albumoses are present, which dissolves on boiling and reappears upon cooling.

Bence-Jones albumose is found in pathologic conditions involving the marrow of the long bones, as multiple myeloma, cancer, myeloid leukemia.

It is distinguishable from ordinary albuminuria by the production of cloudiness in the urine when heated to 122° or 140° F. (50° or 60° C.), and by solution

of the precipitate at higher temperatures. It is of grave prognostic significance and runs a fatal course within two years.

INDICANURIA

Definition.—The presence of a pathologic quantity of indican in the urine. Indican occurs in the urine in health in very small quantities, and is, chemically speaking, indoxyl-potassium sulphate.

Pathology and Etiology.—Indican is increased abnormally in the urine by any disorder whereby large quantities of albuminous matters are decomposed. Thus, it occurs in ileus, which produces a stagnation of the contents and a consequent decomposition from bacterial action. Under such circumstances indol and phenol are formed. The former, being absorbed and oxidized into indoxyl, finally appears in the urine in combination with potassium sulphate. Acute and chronic peritonitis, wasting diseases, and cachectic conditions in which there is a considerable destruction of albuminoids (as in Addison's disease, neoplasms, cholera Asiatica, and empyema) usually have an associated indicanuria. Increased indicanuria occurs when there is an impediment to peristalsis of the small intestine, hence is not seen in simple uncomplicated constipation. It is stated (Piseuti) that any obstruction preventing the flow of the pancreatic juice into the bowel would be reflected in a diminished quantity of indican in the urine. An increased indicanuria is encountered when anachlorhydria or hypochlorhydria exists (*e. g.*, gastric carcinoma—Simon).

Diagnosis.—This depends upon the demonstration of indican by adding strong oxidizing agents, which decompose this product and set the indigo or pigment free. At times the urine may present a cloudy, bluish, or even blue-black appearance. This may be seen in urine that has been standing for some time, the sediment giving a bluish reflection, or there may be a blue turbid film on the surface.

Tests.—*Jaffe's* well-known test consists in mixing equal volumes of urine and hydrochloric acid, and then adding, drop by drop, a concentrated solution of chlorinated lime, shaking the tube after each addition. A strong indigo-blue color appears if there is much indican.

A good modified test is the use of fuming nitrohydrochloric acid and urine (equal parts) and a saturated solution of chlorinated potash, used as in the above method. A blue-black cloud or ring appears below the surface. If a few drops of chloroform are then added and the mixture is agitated slightly, a blue color settles at the bottom, owing to the chloroform carrying with it the oxidized indican.

PYURIA

Definition.—The presence of pus in the urine.

Etiology.—Pyuria is due to (1) suppurative inflammation along some portion of the genito-urinary tract, or (2) to the rupture of adjacent abscesses into the tract.

Pyelitis and Pyelonephritis.—Pus from the pelvis of the kidney may be due to calculous, tuberculous, or other irritation. It is associated at times with the "railed" or transitional epithelium usually seen early in the case. In pyelonephritis casts may indicate renal involvement, although it should be borne in mind that in abscess of the kidney pus may be discharged continuously without the appearance of any casts in the urine whatsoever. One such case came to necropsy under the observation of H. S. Anders, in which small uratic calculi were discharged now and then for several years. Later, several larger stones were removed from the bladder by Willard by suprapubic cystotomy. The abdominal opening healed in a few months, but pyuria persisted. Death oc-

It, by the *Filaria sanguinis hominis* (*vide* Filariasis). It is held to follow on to the lymphatic ducts, and may be associated with pregnancy.

Diagnosis.—The urine is increased in quantity, and has a milky turbidity (*chyluria*) due to the emulsified fat. After standing for a time a light coagulum settles to the bottom and a creamy pellicle of fat rises to the surface. The sediment contains also the fibrin of the chyle. Sometimes as much as 2 per cent. of fat is present (*lipuria*); this may be tested by agitating a portion of the urine with ether, whereupon the turbidity disappears. Owing to the presence of albumin in the chyle, the various tests for that substance would show the presence of its presence in chyluria. Hematuria may be associated with chyluria, especially in parasitic cases, and both the blood and urine should be carefully examined for filaria. *Microscopically*, chyle-containing urine resembles milk with millions of fine granules and fat-droplets.

Prognosis.—Chyluria is intermittent in its appearance, corresponding to the times of rupture of the vesical lymphatics, and may last for years. The prognosis of non-parasitic chyluria is good as to life, but unfavorable as to cure.

CHOLURIA

Definition.—The presence of bile-pigment in the urine.

Etiology.—Choluria may be caused by any disease, local or general, of which jaundice is a symptom.

Diagnosis.—Bile-stained urine has a color varying from a greenish-yellow to a brownish-green or brown-black, resembling porter. When shaken it immediately assumes a characteristic yellow or greenish-yellow color. White filter-paper dipped in the urine is stained yellow.

Tests.—The *chloroform* test consists in adding this substance to the urine, allowing it to settle to the bottom of the tube. If bile or pigment be present, the gravitated chloroform will be colored yellow.

Gmelin's test is most commonly employed, though it is not the most delicate. A few drops of urine and nitric acid are allowed to run together on a white porcelain plate; if bile-pigment (bilirubin) be contained in the urine, a play of colors ensues, the green predominating, followed by the blue, violet, and red, each shade representing a new form of pigment. The first color noticed (green) corresponds to the biliverdin or normal bile-pigment of herbaceous animals. The oxidation of bilirubin into biliverdin is better accomplished by nitric acid containing a little nitrous acid. Hence, the test may be improved by adding a little fuming nitric to ordinary nitric acid to form a yellow trace of the nitrous acid. This may be placed in a test-tube, and some of the urine added gently with a pipet. Bile-pigment will be indicated by successive rings of green, blue, violet, and red from above downward; this occurs, however, only when considerable bile-pigment is present.

Rosenbach's test is a modification of Gmelin's, and is more distinct. The urine is first filtered, and a drop or two of the nitric-nitrous acid is then poured on the filter-paper, when the characteristic colored rings will appear if bile be present. According to Penzoldt, the Gmelin-Rosenbach test is made more distinct by acidulating the filtrate with acetic acid and pouring a thin layer into a white shallow dish. The acetic acid assumes a greenish-yellow, and later a green, or even a blue-green shade if bile be in the urine. This reaction is quickened or intensified by the application of heat to the liquids.

In the *Marechal-Rosen test* a mixture of 1 part of the tincture of iodine and 2 parts of alcohol is spread in a deep layer over the suspected urine in a test-tube or glass. A grass-green ring forms at the point of contact in choluria.

Bile-acids.—These are principally the glycocholic and taurocholic acids.

Traces are found in normal urine, and their clinical significance or diagnostic importance, as far as is known, is practically *nil*.

Other constituents of the urine in choluria of long standing are slight quantities of albumin and icteric or yellow bile-stained hyaline or finely granular casts.

A point in **differential diagnosis** should be noted. *Certain drugs*, as rhubarb and santonin, when given internally may produce a discoloration of the urine similar to that caused by the presence of bile. On agitation, however, there will be no yellow foam and no reaction to the tests for bile, while the addition of liquor potassæ causes a red color.

UROBILINURIA

Definition.—The presence of quantities of pathologic urobilin in the urine. It is derived from bilirubin as a product of the reduction of this substance.

When present in large quantities urobilin gives to the urine a red-brown color. This is seen in fevers, varying in depth of shade according to the degree of pyrexia; also in diseases of the liver, after hemorrhagic effusions (due to resorption), in the hemorrhagic diathesis, in purpura, and in progressive pernicious anemia.

Diagnosis.—The presence of urobilin is best detected by a spectroscopic examination. A marked absorption band between Fraunhofer's lines (f and b), fading off from the green into the blue, is characteristic. Chemically, the addition of a few drops of a watery solution of zinc chlorid to the urine will cause the peculiar red-green fluorescence of urobilin to appear.

GLYCOSURIA

Definition.—The presence of sugar (glucose) in the urine. Normally, a trace of sugar is present in the blood (glycemia); abnormally, it may be excreted in the urine when the blood concentration reaches a certain point—0.15 per 100 c.c. blood. Folin,¹ however, with an extremely sensitive reagent found sugar in every case on examining the urine of about 100 students.

Etiology.—A continuous excretion of sugar is seen chiefly in untreated cases of diabetes mellitus. At times lesions affecting the floor of the fourth ventricle may cause persistent glycosuria. A normal person may take by mouth 100 grains of glucose without the occurrence of a glycosuria. A diminished tolerance, or inability to metabolize properly smaller quantities than this will be followed by a glycosuria, an alimentary or digestive glycosuria which occurs frequently in the following conditions: Certain diseases, as gout, cholera, typhoid, typhus, and scarlet fevers, whooping-cough, diphtheria, malaria, tetanus, and phthisis; hepatic cirrhosis; organic nervous diseases, especially those affecting the medulla and involving the floor of the fourth ventricle; psychic causes, as excessive mental exertion, extreme emotional activity (grief, worry, and shock), from injuries and after operations, such as cerebral concussion and hemorrhage, and fracture of the skull, from acute cerebrospinal meningitis, and after epileptic paroxysms; pregnancy (10 per cent. of the cases—Wormmüller); certain toxic agents, among these being cyanogen monoxid, morphin, atropin, hydrocyanic acid, amyl nitrite, curare, alcohol, mercury, arsenic, turpentine, copaiba (Bettman), adrenalin, picrotoxin, and various coal-tar derivatives, as salicylic acid and salol; obesity (rare disturbance); pancreatic disease (chronic interstitial pancreatitis is not commonly, pancreatic calculi, carcinoma, and cysts); exophthalmic goiter or other disturbances of the thyroid; ingestion of alcohol, carbonyl compounds,

¹ *Jour. Biol. Chem.*, 1915, xxii, 327.

glucose in excess. A renal type of glycosuria is occasionally met with in which the renal threshold is so lowered that even when there is a small amount of blood-sugar, glucose is excreted by the kidneys.

Allen, Wishart, and Smith¹ believe, as a result of study of a large number of diabetic cases in the U. S. Army, that so-called renal glycosuria is not especially uncommon; that trauma may play a part in the etiology of the condition; that, in the 3 cases at least which they studied, there was no evidence of nephritis; that unrestricted diet does the patient no harm, whereas attempts to control the diet does have a baneful effect; that there is no fixed relation between the sugar in the blood and urine; that the available preformed carbohydrate seems to have the most influence on the sugar excretion; and that neither Frank's hypothesis of a high plasma sugar nor an abnormality in the kidney nor a lowering of the normal threshold of sugar excretion have been established as the pathogenic factor responsible for the condition.

Diagnosis.—The daily quantity of the urine of typical glycosuria—i. e., when masking saccharine diabetes—is greatly increased (60 fluidounces—2 liters—and over *per diem*); it is of high specific gravity (1025 and over), of a clear, pale-yellow color, a “ripe-fruit” odor, a sweetish taste, and an acid reaction that is intensified on standing, owing to the fermentation of the sugar. Albuminuria may be associated with glycosuria, and the albumin should be removed before testing for sugar.

Tests.—These depend mainly upon the peculiar property of glucose in reducing the blue oxid of copper to the orange or red suboxid.

(1) *Fehling's Test.*—Two solutions are used, equal parts being mixed to form Fehling's solution, as follows:

Solution I contains 34.64 gm. of cupric sulphate, dissolved in enough water to make 500 c.c. Solution II: 173 gm. of Rochelle salt are dissolved in 480 c.c. of sodium hydroxid; this is then diluted with water up to 500 c.c.

Application: Dilute 1 c.c. of Fehling's solution (about 10 drops of each of the above solutions) with about 1 dram (4 c.c.) of water in a test-tube, and heat to the boiling-point. If the clear blue color remains, the solution is ready for use; should it change color, however, the solution is unfit for use and should be discarded. The suspected urine is added, drop by drop, heating occasionally, when, if glucose be present, the blue color will be discharged by a yellow turbidity, which increases until finally a deep-yellow or orange-red precipitate falls. Bluish-white flakes and a greenish discoloration of the mixture simply indicate cupric hydroxid, and not glucose. This test serves for the detection of .001 per cent. of glucose (Wormley). It cannot be applied to strongly ammoniacal urine.

(2) *Trommer's Test.*—To about 5 c.c. of urine in the tube add one-third or one-half its volume of potassium or sodium hydroxid, and then, drop by drop, add a 10 per cent. solution of cupric sulphate. If a bluish-white precipitate falls, either filter or agitate the liquid until it assumes a slight and uniform turbidity; then heat, and, if sugar be present, a yellow or red deposit of cuprous oxid falls: 0.01 per cent. of glucose may be detected in this way.

There are certain other substances which when present in urine make the copper tests fallacious by reducing the cupric to cuprous oxid (mucin, lactose, uric acid, pyrocatechin, hydrochinon, bile-pigments, glycosuric acid, the products of elimination after the ingestion of chloral—urochloric acid—and benzoic and salicylic acids). Among normal constituents that can reduce cupric oxid are uric acid, creatinin, and hippuric acid. “Alkapton” urines also reduce Fehling's solution. If care is taken to heat the urine almost to the boiling-point, but not actually boil it, the great majority of these substances

¹ *Arch. Int. Med.*, 1919, xxiv, 523.

Acetonuria may exist to a minute degree in health, the acetone being a product of the normal metamorphosis of albumin. It may be present also in—(1) diabetes; (2) carcinoma; (3) febrile conditions; (4) inanition; (5) psychoses; (6) intestinal toxemia, especially with fatty acids in the stomach and intestines (enterogenous acetonuria); (7) pregnancy; (8) after anesthesia; (9) in cyclic vomiting; (10) in certain intestinal complaints of children. Urine that contains acetone in pathologic quantities has a fruity (apple-like) odor or one resembling that of chloroform.

Tests.—(1) *Gerhardt's* original test consisted in the addition of a few drops of the tincture of the chlorid of iron, which produced a Burgundy-red color with acetone or, rather, with the aceto-acetic acid.

(2) *Nitroprussid Test.*—To a fluidounce (30.0) of the urine add 1 or 2 drams (4.0–8.0) of a solution of sodium nitroprussid (gr. v to ʒj—0.3–30.0) and a few drops of strong aqua ammoniæ. On standing a rose-violet color appears. According to Legal, proportionately smaller quantities of urine and the reagent may be used, and strong liquor potassæ. A bright red color develops, and fades rapidly, but upon adding acetic acid this changes to purple or violet red (Vierordt). This is a better test.

(3) Perhaps the most accurate and, at the same time, satisfactory test for acetone is the following: Distil the urine with a little phosphoric acid, and add to the distillate a few drops of sodium hydroxid and of Lugol's solution. If acetone be present, yellow crystals of iodoform will form, with the characteristic odor.

Diacetonuria and **oxybutyria** never occur normally. They are often associated with acetonuria in diabetes, and sometimes in fever, or occur as an independent disease (V. Jaksch). "The persistent excretion of more than 25 grams of beta-oxybutyric acid indicates impending coma" (Simon). Stadelmann affirms that of like value in diabetes is the determination of a marked and increasing amount of ammonia in the urine (1 gram—gr. xv—and more *per diem*), as indicating the imminence of diabetic coma. Diacetonuria is found to occur in certain acute diseases of children, accompanied with convulsions.

Tests.—The presence of diacetic acid is demonstrated by the chlorid-of-iron reaction, as in the case of acetone, except that the urine is boiled previously. This is done to avoid fallacy, since in unboiled urine acetic, formic, and oxybutyric acids may strike a Burgundy red also; in urine that has been previously boiled these do not react, while the diacetic acid does, if present. Tests for the latter, therefore, need not be detailed here (*vide* Tests for Acetone).

LITHURIA

Definition.—A persistent excess of uric (lithic) acid and urates (lithates) in the urine. Uric acid occurs in the urine in combination with alkalies, but may become free, separating out as a crystalline deposit.

Normal urine contains about 0.4 part of uric acid to 1000 parts of urine (about gr. x—0.6—*per diem*), or it exists in the proportion of about 1 to 45 of urea, the principal solid constituent.

Etiology.—An excess of uric acid may be excreted in the following conditions: (1) gout and rheumatism; (2) fever; (3) leukemia and pernicious anemia; (4) pulmonary affections in which the interchange of gases is interfered with; (5) a highly nitrogenous diet. Certain other conditions of the urine may diminish its power of dissolving the uric acid shortly after voidance, and may cause a deposit that should not be mistaken for an excess. Such are: (a) temporary increase in the quantity of uric acid from an overindulgence in nitrogenous food; (b) temporary high acidity; (c) deficiency in mineral salts.

Diagnosis.—By the ordinary clinical tests it is impossible to estimate with any degree of accuracy the amount of uric acid eliminated, though

(of calcium and magnesium) or of *alkaline phosphates* (of potassium, sodium, and ammonium). They are also found in the decomposing urine of chronic cystitis, of phosphatic vesical calculi, of paralysis, and in undue retention of urine. In this alkalinity, due to the ammoniacal fermentation of urea, ammonium carbonate reacts with the phosphates of magnesium to form the triple ammonio-magnesia-phosphatic crystals, the commonest variety of phosphaturia. Here the phosphates are deposited before or immediately after the urine is passed, giving a milky appearance to the last portion. Deposits of phosphates, and especially of triple phosphates, however, do not indicate an actual phosphaturia. This must be determined by chemical analysis. *Amorphous carbonate of lime* in small quantity may be present also if the urine is strongly alkaline and ammoniacal (Beale). The *calcium phosphates* are generally more abundant than the magnesium, and may be found in cases of nervous or atonic dyspepsia, neurasthenia, and other debilitated conditions. The alkaline phosphates (which represent three-fourths of the phosphoric acids), being easily soluble, do not form a deposit.

A quantitative estimation of the daily output of phosphates shows a decided increase in wasting diseases, as tuberculosis, leukemia, chronic articular rheumatism, and acute yellow atrophy of the liver. The phosphoric acid, however, is not increased. The so-called "phosphatic diabetes" is characterized chiefly by excessive phosphaturia.

Diagnosis.—Phosphatic urine has usually a stale ammoniacal odor, a whitish turbidity, and a copious light colored granular sediment falls on standing. *Microscopically*, the calcium phosphate crystals appear singly as "knife-blade," "arrow-head," or "slender wedge-shape," or in stellate clusters. Acetic acid dissolves them. The ammoniomagnesium phosphate crystals are transparent rhombic or triangular prisms, large and small—"coffin-lid shaped." These also are soluble in acetic acid; oxalate of lime crystals are not so.

On heating phosphatic urine an increased cloudiness is produced that simulates albumin, but on acidifying, as with a drop of nitric acid, this is cleared up at once.

LEUCINURIA AND TYROSINURIA

Definition.—The presence of leucin and tyrosin in the urine. These are strictly pathologic substances, and are usually found together. They are products of the decomposition of albumin.

Etiology.—The principal causes of leucinuria and tyrosinuria are acute yellow atrophy of the liver and acute phosphorus-poisoning (in both of which fatty degeneration is conspicuous). They occur in traces constantly in diseases of the liver, cholelithiasis, catarrhal jaundice, specific infectious diseases, as typhoid fever, small-pox, and yellow fever, and pernicious anemia.

Diagnosis.—Leucin is the more soluble, hence is rarely found in the urinary sediment. Tyrosin, on the other hand, may be discovered sometimes as a fine greenish-yellow deposit. Bile-pigment and a trace of albumin may be found not infrequently in urine containing leucin and tyrosin. Urea is, as a rule, markedly diminished. Leucin and tyrosin may be detected by evaporating a few drops of urine on a glass slide and examining microscopically. Leucin appears in the form of slightly glistening, greenish-yellow spheres that may show radiating lines and concentric rings. Tyrosin is recognized by the slender tufts of fine, needle-like crystals arranged in star- or cross-like fashion.

If the residuum after evaporation be heated with a drop of nitric acid, slowly evaporated to dryness, and then touched with a drop of sodium hydroxid, the leucin, if present, will assume a yellowish-brown hue. Tyrosin becomes red in color when boiled with Millon's reagent of mercurous nitrate, and a violet color when warmed with a little sulphuric acid, and then treated with a drop of the solution of phenic chlorid.

tions and exudations, and in intermittent fevers, owing to the destruction of the red corpuscles.

Pathologic *diminution* in the quantity of chlorids occurs in fevers, in the nephritides, in cachectic conditions, and especially in such diseases as pneumonia, pleuritis, and rheumatism. In the last-named class the chlorids diminish as exudation continues, and may even totally disappear from the urine in extensive pneumonic consolidations, to reappear again with the resorption of the exudate.

Test.—The chlorids may be detected, after first removing any albumin that may be present, by acidulating with a few drops of nitric acid (to keep the phosphates in solution), and by then adding, drop by drop, a strong solution of argentic nitrate. According to the abundance of the resultant white, curdy precipitate of argentic chlorid a rough estimate may be made of the total quantity of chlorids in the urine.

Lipuria is a term applied to the presence of fat in the urine. It may result from the steady use of cod-liver oil or of fatty food, or it may be found in pyonephrosis (Ebstein); in phosphorus-poisoning; in prolonged suppuration; in the lipemia of diabetes mellitus; in the "large white kidney" with fatty degeneration of chronic Bright's disease; in beer-drinkers, and in chyluria. Fatty urine becomes clear upon agitating after the addition of ether.

Lipaciduria, or urine containing volatile fatty acids (acetic, butyric, and propionic), is as yet without diagnostic significance.

Melanuria, or urine containing the pigment melanin, is found in cases of melanotic sarcoma. The urine is dark, either just after being voided or after some exposure and oxidation.

Hematoporphyrinuria (*Urospectrin*).—This term implies the presence of hematoporphyrin (iron-free hematin) in the urine. It occurs after long-continued use (even in small doses—Müller) of saffron and certain coal-tar products (sulfonal, trional). Stockton found it in acute ascending paralysis. In addition to the gastric and nervous *symptoms* in poisoning from these substances is a cherry-colored or dark blue-red urine, the abnormal appearance of the latter being due to the presence of hematoporphyrin resulting from the destruction of the red blood-corpuscles. The condition has proved fatal in cases in which the kidneys were diseased. The urine is always quite acid. According to Garrod, hematoporphyrin is a scanty though constant ingredient of normal urine. He extracts it by adding 100 c.c. of urine to 20 c.c. of a 10 per cent. solution of sodium hydroxid. This precipitates the phosphates, which are washed with water and redissolved with rectified spirits. After acidulation with hydrochloric acid the solution shows spectroscopically bands of acid hematoporphyrin. The *treatment* consists in the withdrawal of these drugs and the administration of alkalies.

Pneumaturia, or gas formation in the bladder, rarely occurs. Heyse records a case of myelitis in which this condition was present.

Fibrinuria.—In certain conditions of the genito-urinary tract, particularly pyelitis and ureteritis, fibrinous (and mucous) shreds are found in the urine. Fibrinuria may follow nephrolithiasis (v. Jaksch).

Bacteriuria.—The tubercle bacillus is not uncommon in the advanced stage of pulmonary and in renal or vesical tuberculosis. Typhoid bacilluria occurs probably in about 25 per cent. of the cases of typhoid fever (Horton Smith, Gwyn). Dick and Dick¹ have shown the presence of bacteria in the urine in a considerable number of patients (66 per cent.) with manifest foci of infection.

Lactosuria.—Lactose is found in the urine of some puerperæ.

Inosituria.—Inosite occurs in the urine in diabetes mellitus, diabetes insipidus, and chronic interstitial nephritis.

¹ *Arch. Int. Med.*, 1917, xix, 493.

necessary for the patient to eat three full meals a day (at 8 A. M., 12 M., 5 P. M.), writing down the approximate quantities taken. No food or is allowed except at meal times.

The urine is to be collected every two hours from 8 A. M. to 8 P. M., while night specimen consists of the urine excreted between 8 P. M. and 8 A. M. Actual collection of the urine is essential to accurate results.

A normal test yields "a maximum specific gravity of 1018 or more, the specific gravity varies 9 points or more from the highest to the lowest, and night urine is small in amount (400 c.c. or less) and of high specific gravity 8 or over."¹ Diminished renal function is indicated by lowering of the maximal specific gravity with fixation of the specific gravity and nocturnaluria.

This simple procedure of estimating the volume and specific gravity of urine following test meals gives important information regarding the ability of the kidneys to excrete concentrated urine and is of especial value in earlier stages of chronic nephritis. However, in some instances it is impossible to determine the salt and nitrogen content of the total day and night excretion as estimated by the Volhardt and Kjeldahl methods respectively.²

1. Blood Urea, Uric Acid, Creatinin.—Ambard has devised a formula expressing the relationship existing between the concentration of the urea in the blood and the rate of urea excretion in the urine. This complicated formula has been simplified by McLean, but in spite of this simplification the test gives no more evidence of nitrogen retention than the simple estimation of the blood urea and it has not stood the test of time as a prognostic sign of particular merit. Blood urea nitrogen is probably the best indication of nitrogen retention and the influence of treatment upon the retention that we have for clinical use. Normally 10 to 15 mg. of urea per 100 c.c. can be found in the blood. The upper limit of these normal figures represents the beginning of nitrogen retention and a decrease in the permeability of the kidney. From this comparative low figure as compared with as high as 300 mg. of urea may be found in the blood of the severe nephritides. The percentage of urea in the blood can be affected readily by treatment and for that reason is a splendid index of the result of treatment. As a prognostic sign it is also of value because it is safe to presume that the higher the figures, the greater the insufficiency of the kidney. For the reason, however, that the blood urea is affected by treatment Myers and Killian³ believe that creatinin, which is entirely endogenous on a meat-free diet and its formation very constant, is a more reliable index of severe renal injury than any other method. They report on 85 cases of severe nephritis in which the blood creatinin was 5 mg. per 100 c.c. (normal). Eighty of these patients are now dead. The report deals with observations made within the last four years. The uric acid content of the blood is also a splendid index of the degree of nitrogen retention and an extremely delicate early test of impairment of the kidneys. Normally it is 2 mg. of uric acid is found in each 100 c.c. of blood. These figures increase as the degree of nephritis increases, so that figures as high as 10 and 11 and higher may be reached.

2. The Concentrating and Diluting Capacity of the Kidney.—Normally the kidney is capable of concentrating the urine when small amounts of fluid are ingested, or of diluting the urine when fluid to excess is taken in. In disease these two functions may be markedly disturbed, so that, for example, no matter how dry the diet is, the concentration of the urine as estimated by the specific gravity cannot be increased, and the diluting capacity may be lost,

¹ Mosenthal and Lewis, *Jour. Amer. Med. Assoc.*, September 23, 1916.

² For technic, consult standard works on Clinical Diagnosis.

³ *Amer. Jour. Med. Sci.*, 1919, clvii, 674.

either long or short and narrow or broad, of a clear, homogeneous substance, delicate in outline, and often showing ends with a cheesy or wax-like fracture. They may be straight or slightly curved and tortuous. Rarely, a cast may be found equal to a millimeter in length. The so-called *narrow casts* are about equal in width to the diameter of a leukocyte, while the *medium* and *broad casts* are from three to four times this size. Hyaline casts are usually associated with other varieties of casts, though in fevers, renal congestion, chronic interstitial nephritis, and in amyloid kidney they may occur unassociated with other forms. Burri's India-ink method of staining for the detection of casts is highly recommended by Stövesandt.¹

(b) *Granular casts* are nothing more than hyaline casts with fine or coarse granules superadded. The granules represent minute, opaque particles of urates, albumin, fat, cellular debris, and even bacteria (*bacterial casts*). It should be remembered, however, that granular casts may be simulated by casts of coagulated albumin covered with particles of hematin or of urates, especially in acute nephritis. The hematin can be recognized, however, by the brownish-yellow coloration.

(c) *Epithelial casts* are hyaline casts more or less covered with renal epithelium, indicating desquamative nephritis (Fig. 61). The epithelial cells may show evidence of granular or fatty change.

(d) *Blood-casts* consist of soft hyaline casts having blood-cells embedded in them. These are present in acute hemorrhagic nephritis and acute renal congestion.

(e) *Waxy casts* are similar in appearance to hyaline casts, though better defined, broader as a rule, and of an opaque, slightly yellowish tint. They often show broken ends (Fig. 61). They do not necessarily indicate amyloid disease of the kidney, as was formerly held. They may, however, sometimes show the amyloid reaction with iodine and potassium iodide, and are always suggestive of serious renal disease.

(f) *Fatty casts* are such as have left upon and in them fat-droplets or granules (Fig. 60), which, if abundant, are indicative of fatty degeneration of the kidney. They occur in serious forms of chronic nephritis of any type, which has become unusually protracted. Cells showing granulation may be seen.

Rolled casts or *pseudocasts* (sometimes made by sliding a cover-glass over a specimen of urine) of urates should not be mistaken for genuine tube-casts. Blood-casts (due to hemorrhage), consisting of fibrin and epithelial pseudocasts (hollow), in cases of desquamative nephritis, also belong in this category. Cylindroids are distinguishable from hyaline casts by their greater length, tapering ends, and by being at times beset with leukocytes, red corpuscles, epithelial cells, and certain crystals. Cylindroids are of no significance unless present in considerable numbers, when they indicate kidney irritation and an abnormal increase in mucous secretion.

2. Epithelium.—Renal cells are found in the urine of those forms of nephritis that are characterized by a catarrhal or desquamative and exudative process in the tubules. Epithelial cells from the kidney are polygonal or spheric in contour, with an indistinct cell wall; they have a large oval nucleus, and are either abundantly granular or show a fatty change. These cells are about the size of the white corpuscle.

3. Leukocytes.—Only when attached to casts can it be positively affirmed that leukocytes are of renal origin (Strümpell). The pus-cells are frequently seen to be without nuclei in marked or chronic pyuria.

4. Red Blood-corpuscles (*vide* Hematuria, p. 938).—In acute hemorrhagic

¹ *Practical Med. Series*, 1911, i, 384.

nephritis and in severe renal congestion free red blood-corpuscles are generally to be found.

5. **Fat-globules and fatty degenerated cells** are seen especially in sub-acute and chronic nephritis with fatty degeneration of the proliferated epithelium, or in the fatty stage of large white kidney.

DROPSY OF RENAL DISEASE

Since, as in other conditions, renal dropsy or edema is an abnormal accumulation of watery fluid transuded from the blood-vessels into the cellular tissues and lymph-spaces, the question arises, "What is the rationale of its development in nephritis?" On the ground that in most forms of nephritis the urine is diminished, it was formerly held that the dropsy was due to the saturation of the tissues with the water that was not excreted by the kidneys. This theory is not tenable, however, for there are some cases of edema unaccompanied by any diminution in the daily quantity of urine; on the other hand, certain instances of renal disease in which there is almost a state of anuria show no evidence of dropsy whatever. Landerer holds that the relaxation of the tissues (which may be caused by the increased transudation of stasis, or by hypnutrition from hydremia), and their consequent loss of elasticity, prevent that forcing of the lymph into circulation that exists in the normal state, and as a result a watery infiltration of the tissues is permitted. From recent experiments edema is due, at least in part, "to toxic substances accumulating in the blood and exciting an injurious action on the endothelium of the capillaries" (Edsall). Pearce concludes that plethoric hydremia and vascular injury have equal value with nephritis in the production of edema, and that none of these three factors acting alone, and no combination of two acting together, is sufficient to cause edema. The chlorid retention theory, namely, that there is an abnormal amount of sodium chlorid in the tissues of persons manifesting renal dropsy (in consequence of which an accumulation of water in order to keep the chlorids in solution occurs), is widely accepted at the present day. Jürgens studied concentration camps of prisoners of war and described an "edema disease," resulting from a metabolic upset from dietary deficiency, and wherever this was recognized and a more varied diet provided, the men soon threw it off or its appearance was averted. Martin H. Fisher holds that the edema of nephritis is due to acidosis.

The dropsy of the nephritides may be either slight or marked, local or general (anasarca), and sudden or slow in onset. It is purely renal in origin perhaps only in acute Bright's disease or in the earlier stages of chronic Bright's disease. In all forms of chronic nephritis the dropsy may be due, in part, to the venous stasis of cardiac incompetency. In chronic interstitial nephritis, especially, edema is slight, and usually is the result of weakness and dilatation of the heart. I desire to mention here those rare cases of dropsy that simulate Bright's disease in which no satisfactory causative lesion is apparent or discoverable, and also those cases, rarer still perhaps, that have a peculiar family or congenital origin.

Physical Signs.—The recognition of edema is made possible by both *inspection* and *palpation*. Renal dropsy is manifested first by puffiness of the skin of the face, and especially of the eyelids. At other places where there is loose subcutaneous cellular tissue, and in particular where the parts are dependent, dropsy is most apt to be seen early, as under the malleoli of the ankles, the dorsum of the foot, and the scrotum. Later, the limbs and the lower part of the back become swollen, and the whole body is involved in severe cases. The skin has a peculiar waxy pallor and a glossy appearance. When

vascular or cardiac changes exist, so as to permit of increased dropsy from engorgement, as in cirrhotic kidney, a cyanotic or muddy color of the skin may prevail. Palpation detects pitting due to loss of elasticity in edematous tissues.

Pathologic Features.—Dropsy is most constant and most persistently decided in the large kidney of subacute or chronic nephritis; it is most uncommon and irregular in chronic interstitial nephritis (contracted kidney). There is also a doughy or putty-like consistence. In very marked cases of dropsy the deeper parts, such as the muscles, become affected. The serous cavities also in general anasarca show evidences of effusion, and thus give rise to hydrothorax, hydroperitoneum, and hydropericardium. Less frequently there may be edema of the larynx, uvula, conjunctiva, and other mucous membranes. Edema of the brain, either local or general, may be the cause of grave uremic symptoms in chronic nephritis, or of unilateral convulsions or paralysis and apoplectic seizures. The dropical liquid is chemically similar to a diluted blood-serum. A minute quantity of albumin and urea is present.

UREMIA

Definition.—Uremia is the term applied to a group of manifestations, mainly nervous and either acute or chronic, resulting from a toxemia due to the retention in the body of certain products which should normally be eliminated by the kidney or else which are the result of perverted metabolism during kidney disease.

Our present knowledge of the **pathology** and **etiology** of uremia, as of renal edema, is based largely upon theoretic views. The theory that attributes uremic symptoms to the retention of the excretory products appears to have the strongest proofs to support it. Thus, many cases of uremia are seen in whom the non-protein, the uric acid, the creatinin, and urea nitrogen of the blood are very markedly increased. That the increased urea may have a very distinct effect is suggested by the experiment of Hewlett and his co-workers, who developed dizziness, sleepiness, and headache following the ingestion of 100 gm. of urea, when the blood urea was over 70 mgm. On the other hand, uremia without nitrogen retention frequently occurs. It may be presumed from the experiments of Foster, who isolated a toxic substance from the blood of convulsive uremics which, when injected into animals, caused death, that toxic substances arise as a result of disturbed renal metabolism.

Not only some of the solid urinary constituents accumulate in the blood in uremia, but the water also is only partly eliminated, and its presence in the blood renders the latter hydremic and of lower specific gravity. Notwithstanding the fact that most cases of uremia may be traced to a marked simultaneous diminution in the quantity of urine passed, there remain still certain instances of renal disease in which uremic symptoms appear without any such perceptible diminution. Even more frequent perhaps are those perplexing cases of anuria now and then reported in which no uremic symptoms appear. In the latter instances it is probable that the elimination of products normally excreted by the kidneys may be accomplished through other channels, as by the skin and bowels; in the former it is still likely that the solid urinary constituents are retained.

Foster¹ differentiates three basic types: "The first is a simple retention of urinary nitrogenous waste, a urinary poisoning; the second is due to defective water and salt metabolism, resulting in cerebral edema; the third type is a toxemia, resulting from an abnormal catabolism."

The symptoms of uremia may be either acute or chronic in onset, severity,

Circulatory Disturbances.—The pulse is moderately slow, tense, and full in uremia, but with the onset of acute and severe symptoms, as convulsions, it usually becomes accelerated, small, and feeble. The blood-pressure remains high until convulsions supervene, after which it rapidly declines. Indican has been demonstrated in the blood in uremia; this is absent in other pathologic states.¹ G. Dorner concludes the presence of indican in the blood in large quantity is characteristic of outspoken uremia, and when present in considerable amount it is also found in pleural exudates and anasarctous fluid. Blood nitrogen is markedly increased in many cases.

Respiratory Symptoms.—Renal dyspnea, which is sometimes called “uremic” or “renal asthma,” is a marked and often an early symptom of uremia. I believe that it is the most constant symptom of this serious condition. The respirations are deep and often stertorous in coma, or they may be irregular, accelerated, and shallow, sometimes assuming the Cheyne-Stokes type. Dyspneic attacks are especially apt to occur at night. In chronic uremia slight dyspnea may be continuous for a long time. Again, alternating paroxysmal exacerbations may arise. The uremic dyspnea is probably due to the acidosis so frequently associated with kidney insufficiency. It may, however, be the result of cardiac weakness or of dropsy or pulmonary edema.

Gastro-intestinal Symptoms.—Uremic stomatitis is generally seen. The breath is foul, the tongue, lips, and gums are red, swollen, and painful, and the saliva is increased. Uremic vomiting is also usually of centric origin. The vomiting may come on suddenly and be persistent. Uncontrollable hiccup and sometimes uremic diarrhea may be associated. There may be produced in the intestines a catarrhal or diphtheritic inflammation, and ulceration even. Uremic diarrhea may also exist apart from any gastric disturbances.

General Symptoms.—The *skin* of the face is usually pale in uremic coma. The skin is often harsh and dry, as in chronic interstitial nephritis. Itching of the skin is intense. The *temperature* is generally lowered, but uremic fever frequently accompanies the convulsions or they may be preceded by “uremic chills.” In some cases the temperature rises to 105° to 107° F. (40.5°–41.6° C.) just before death, while in other cases, characterized by coma that deepens into collapse, the temperature may be so low as 91° or 93° F. (32.7°–33.8° C.).

There is not infrequently an *ammoniacal odor* about a uremic patient. The *urine* is diminished in quantity and is generally highly albuminous. A previous dropsy is sometimes markedly reduced upon the appearance of acute uremic symptoms.

Duration and Prognosis.—Acute uremia is manifested by coma and convulsions, seldom lasting more than a few days. Chronic uremia, in which milder nervous symptoms, nausea and vomiting, and dyspnea are more prominent, may persist, however, for many weeks. While a grave condition, uremia, even in its most acute and violent forms, is not at once necessarily fatal, for under proper treatment—as by venesection, for instance, followed by judicious hygienic measures—life may be considerably prolonged. Sooner or later, however, barring a possible death from some intercurrent affection, a fatal result is inevitable. Indicanemia, while not toxic in its effects, is, nevertheless, a sign of approaching exitus, as a rule. Likewise, a steadily increasing amount of non-protein nitrogen and an increase in the blood urea with marked change in the percentage of the urea of the blood nitrogen is indicative of a fatal outcome. The converse, on the other hand, shows that improvement is likely to occur. The phthalein elimination is also a valuable

¹ For test, see *Zentralblatt für Innere Medizin*, December 23, 1911; by W. von Moraczewski and E. Herzfeld.

duction of salt solution and the use of salt in the diet. Frey recommends lumbar puncture to evacuate toxins and reduce pressure on the brain in the convulsive type.

AMYLOID KIDNEY

Definition.—Amyloid (waxy or lardaceous) degeneration of the kidneys is usually coexistent with a similar degeneration of other viscera.

Pathology.—Macroscopically, the amyloid kidney appears pale, greenish or yellowish-white, firm, and uniformly enlarged, and the surface is smooth, glistening, and often mottled, owing to the prominence of the stellate veins. On section a homogeneous, anemic or “bacon-like” surface presents itself, particularly in the cortical region. The cortex is wider than normal; the pyramids may be red in color and slightly infiltrated; and the glomeruli may show an infiltration by the glistening, translucent amyloid (albuminoid) material. On the application of Lugol’s solution of iodine to the amyloid areas a mahogany-red color is produced. Brushing over the amyloid substance with a solution of iodine, and then with dilute sulphuric acid, gives a blue or violet tint. Similarly used, a 1 per cent. solution of methyl-violet strikes a red color. The capsule of the kidney is thickened, though not always adherent.

Microscopically, the amyloid change is generally found in the early stages to affect the walls of the capillaries of the malpighian tufts. The walls are swollen with the homogeneous material and the vessel lumen is diminished or obliterated. The straight uriniferous tubules are also infiltrated later perhaps, the deposit occurring primarily in the membranæ propriæ. A diffuse nephritis is nearly always an associated condition. The tubules generally contain hyaline casts. Fatty degeneration of the epithelium, glomerulites or waxy glomeruli, and a thickening of Bowman’s capsule are common in markedly amyloid kidneys. In advanced cases most of the secretory structure becomes atrophied. Amyloid infiltration of the smaller granular kidney is less common than of the large white kidney, with intense parenchymatous changes.

Hypertrophy of the heart is not always present in amyloid disease of the kidneys. Amyloid infiltration of other organs, however, as of the liver and spleen, is usually associated with waxy kidneys.

Etiology.—The causes of amyloid kidney are those of the amyloid change affecting (either simultaneously or nearly so) other organs, as the spleen, liver, and intestines.

Commonly, amyloid disease is marked also in the other solid organs named above; it is secondary to wasting diseases, cachexiæ, and the like. Perhaps the most frequent cause of the waxy kidney is tuberculosis, especially of the lungs (“chronic ulcerative phthisis”); tuberculosis of the intestines also is often associated. Next in order are the prolonged suppurations, particularly of the bones, as in osteitis of the vertebræ and hips (usually tuberculous). Chronic empyema, intestinal ulcers, vesicovaginal fistulæ, and other purulent affections, chronic in nature also, have the same etiologic effect. Amyloid kidney is often present in syphilis, especially in the tertiary stage, when ulceration of the mucous surfaces and of the bones is present. Rarely, gout, malaria, leukemia, cancer, and chronic valvular endocarditis with insufficiency seem to produce amyloid disease. Frank¹ claims to have discovered a bacillus, only slightly pathogenic, of the capsulatus group and thinks it possible that it is Friedländer’s *Bacillus capsulatus*.

¹ *Munch. med. Wchnschr.*, March 28, 1916.

Symptoms.—These vary greatly according to the extent to which the amyloid degeneration has encroached upon the normal kidney structure, and may be overshadowed partially or completely by those of the dominant causal affection.

The *urine* is pale yellow, clear, and variable in quantity, and the amount passed in twenty-four hours is sometimes normal or may be slightly diminished. More frequently, perhaps, it is increased, and especially in marked or advanced cases. The specific gravity is apt to be low (1015–1005), and there is seldom any sediment.

Serum albumin and *globulin* may both be present in the urine; but a highly significant condition, and one that is seemingly diagnostic, is the high proportion of globulin as compared with the serum albumin (Salkowski, Senator). *Tube-casts* may be found, but their presence may be only temporary; they are usually wide, hyaline, fatty and granular, and very few in number (Fig. 61). The amyloid reaction may be elicited with the hyaline casts; symptoms referable to the kidney are often absent in comparison with those of the nephritides. *Dropsy* is not invariably present, and when present is but moderate in degree and generally in the legs only. It is proportionately prominent with the increase in the anemia, circulatory depression, and wasting of flesh and strength. The latter manifestations, constituting a cachectic appearance, are quite commonly observed in amyloid kidney.

The associated enlargement and the firm, sharp outlines of the liver and spleen are of diagnostic significance. *Marked diarrhea* may be due to coexisting amyloid infiltration of the intestines or to tuberculous intestinal ulcers, and is often seen in advanced cases.

Diagnosis.—This can seldom be made upon the urinary manifestations alone. Important and often necessary adjuncts are the histories of causation and of the associated symptoms and physical signs. Thus, there will be evidenced in most cases tuberculosis, chronic bone-suppurations, or syphilis, while coexisting hepatic and splenic enlargements, wasting, and cachexia are usually present. In any of the diseased conditions mentioned amyloid kidney may be diagnosticated with reasonable certainty upon the development of an increased quantity of pale clear urine of low specific gravity and containing a large amount of albumin, or even with slight albuminuria.

From *parenchymatous nephritis* amyloid kidney is to be differentiated by the history, by the more marked and generally distributed dropsy, and by the albuminuric retinitis that characterize the former. In *chronic interstitial nephritis* there are less marked albuminuria and dropsy, and there are present arteriosclerosis, cardiac hypertrophy, and a pronounced tendency toward uremic symptoms.

Prognosis.—This varies with the cause. Incipient bone disease or tuberculosis, with only slight evidences of amyloid change in the kidneys, may be controlled. As a rule, however, the structural alterations are so far advanced, and the constitutional powers of resistance so much enervated, before the amyloid infiltration can be distinctly apprehended that in the majority of instances the prognosis is entirely unfavorable. In decided cases death ensues in from several weeks to as many months.

Treatment.—This also depends upon the causal affection. Hygienic and dietetic measures are always useful, however, with a view to improving the general nutrition. The iodid of iron has been recommended as an alternative, and easily assimilable and palatable fats and tonics may also be tried. Tuberculous cases require creasote or allied preparations; syphilitics require mercurials and iodids; while malarial subjects do best under the systematic use of arsenic, iron, and quinin.

NEPHROLITHIASIS

(Renal Calculi; Pyelitis Calculosa; Renal Colic; Gravel)

Definition.—A condition characterized by the formation of fine or coarse concretions in the kidney substance or in the renal pelvis by the precipitation of certain of the solid urinary constituents.

Varieties.—According to their size, renal concretions are variously termed—(1) **Renal sand**, of which the particles are fine and pulverized. (2) **Renal gravel**, consisting of coarse grains or even of pea-sized concretions. (3) **Renal stone, or calculus**, when larger masses than the preceding exist, either more or less rounded or as stony casts or molds of the pelvis of the kidney, its infundibula, and calyces (*dendritic* or *coral calculi*).

According to their composition, the chemical varieties of renal concretions are: (1) *Uric acid* calculi. Urates are often associated in the calculus with uric acid, thus producing stratification. These concretions may occur as sand, gravel, or large stones; they are usually quite hard, reddish-brown or black in color, and have a smooth though irregularly shaped surface. The fracture is crystalline. Pure uratic stones may occur in children. Mackarell, Moore, and Thomas have shown that the most common constituents of renal calculi are calcium oxalate and calcium phosphate.

(2) *Calcium oxalate* concretions occur more rarely in the kidney. They constitute the so-called “mulberry calculi,” from a fancied resemblance to the mulberry, owing to their dark brown or black color and very irregular and nodulated or prickly appearance. They are also quite dense; lamination, however, is not common, although they are sometimes formed about a uric acid nucleus.

(3) *Phosphatic* calculi of the kidney are still less common than the oxalate, but they are more common in the bladder. They may consist of calcic phosphate or ammoniomagnesian phosphate, and may possibly be associated with calcic carbonate. Phosphatic salts are most often deposited secondarily about uric acid or oxalate calculi in the alkaline urine of a cystitis set up by the irritation of the true renal stones. Phosphatic calculi are grayish-white in color and are comparatively soft.

(4) Renal stones composed of *cystin*, *xanthin*, *carbonate of lime*, *fatty* or *porraceous matters* (urostealith), *indigo*, and *fibrin*, though of extreme rarity, have been occasionally reported. Cystin calculi have a pale-yellow color and waxy luster.

Pathology.—The anatomic changes of the kidney vary with the degree of persistence of the irritation, the size of the calculi, and their passage or retention. Sometimes numerous granular and pea-sized concretions are found in the renal pelvis, with desquamated epithelium and a turbid urine. Interesting cases are those in which a dendritic stone occupies a great portion of the affected kidney substance, as well as the entire pelvis of the organ. In one of my own patients the left kidney was, apparently, nearly twice the normal size, owing to the presence of a large coral calculus (uric acid and urates), connected by an isthmus with a rounded stone in the inferior portion quite as large as a large walnut. The pelvis of the right kidney also contained a dendritic calculus.

Secondary Lesions.—Perhaps the most usual result of renal concretions is pyelitis: this may be simple catarrhal, diphtheritic, or purulent, with or without hemorrhages, depending upon the intensity of the mechanical irritation. Pyelonephritis may follow in severe cases, as may even a general suppuration (pyonephrosis) or perinephric abscess and perforations. Renal pus cavities are sometimes found *postmortem* containing numerous small stones. Hydro-

even, and syncope may ensue. There may be moderate fever. The *urine* is scanty or may be suppressed for a time, and is often bloody. Frequent and painful attempts at urination are made, with the passage of but a few drops at a time, owing perhaps, in part at least, to a reflex spasm of the vesical sphincter (vesical tenesmus). The presence of pus and of pelvic epithelium in the urine indicates a pyelitis. When a large quantity of clear urine is passed it may be looked upon as having come from a healthy kidney.

The *paroxysm* of renal colic ends when the impacted stone passes out of the ureter. This may occur within a few hours or it may take several days; or colic may be intermittent.

Recovery is not always complete upon the evacuation of the stone. The previously retracted testicle may remain painful, and there are apt to be aching and soreness over the affected kidney and ureter.

In certain severe cases of mechanical irritation the symptoms of pyelitis, pyelonephritis with abscess, or hydronephrosis may be superadded. Anuria and uremia may result.

Nephrolithiasis as a *chronic affection* may exist for many years, with recurring paroxysms of renal colic. I observed a case for five years that had extended over a period of thirty years, until it finally came to necropsy. Between the attacks of colic the patient may be entirely comfortable, save perhaps an occasional burning in the urethra on micturition, owing to a highly concentrated, acid urine or to the passage of minute uric-acid granules. There are apt to be pain and tenderness over a kidney containing a large embedded stone. A smoky hued urine, due to slight hematuria, is also sometimes present in long-standing cases of renal calculus, particularly after exertion.

A *renal intermittent* fever may occur in nephrolithiasis, and is analogous to the hepatic intermittent fever of cholelithiasis.

Pyelitis—simple or purulent—with late involvement of the kidney parenchyma (pyelonephritis) is a frequent concomitant of chronic nephrolithiasis. The presence of pus in the urine is constant, with an absence of renal epithelium in cases of an abscess-cavity of the kidney. In ordinary pyelitis the pyuria is often intermittent.

The general health of patients with nephrolithiasis is, as a rule, remarkably good. Anorexia is not only seldom present, but such persons are habitually free and good liver. Persistent headaches with nausea, however, should warn one of uremia. Splenic and hepatic enlargement may be found with prolonged suppurative pyelonephritis, indicating amyloid disease.

Diagnosis.—This resolves itself into a study of the diagnostic characters of (a) the attacks of renal colic, (b) of the underlying systemic condition in general, and (c) the renal condition in particular that renders these attacks possible. The latter can be discovered only by a careful and continuous study of the clinical history and urinary manifestations as outlined in previous paragraphs.

Nephrolithiasis may be positively diagnosed in a case in which, after sudden, agonizing, colicky pain, referred to either lumbar region and radiating down the ureteral course to the testicle, a concretion is found to have passed with the urine. It is therefore necessary in a suspected case of renal colic to pour the urine through a fine sieve as soon as passed. The more recent improvements in the operative technic for producing the roentgen-rays enable us to detect renal calculi with accuracy as to their number, size, and relative position. The injection of collargol through an opaque sound, which has previously been introduced into the pelvis of the kidney, enables a roentgen-ray picture to outline the pelvis and calices.

Differential Diagnosis.—Renal colic must not be taken for *biliary* or

intestinal colic. The antecedent history is of great value in arriving at a diagnosis. In biliary colic there may be jaundice, and pain referred to the upper rather than to the lower abdominal zone, both of which symptoms are absent in renal colic; while in the latter the disturbance of micturition and the character of the urine, especially the hematuria, are characteristic.

In intestinal colic the griping pain is usually most intense in the umbilical region, is often relieved by pressure, and is associated with tympanites and constipation; it has usually a dietetic origin, while the renal and urinary symptoms are absent. The exclusion of *lumbodynia* and *lumbo-abdominal neuralgia* is not so difficult. The differentiation of the varieties of calculi from the symptoms is not positive. It has been suggested, however, that the oxalate stones usually cause the sharpest pains and the hematuria. Right-sided ureteral pain felt over the lower abdominal region may be confounded with *appendicocolic*. Musser has found the pain of renal colic to be more paroxysmal and less uniform in location than in the latter. Early *renal tuberculosis* (*vide*), with its hematuria and pyuria, must be differentiated from renal calculus also. Cases of supposed stone in the kidney with most of the typical symptoms in which, however, no stone was found at operation (false stone), have been reported by James Tyson. In all instances adhesions were found between the capsule and the kidney itself, and all were relieved by operation. In a case of *hypernephroma* under my care the blood coagula induced typical attacks of renal colic at intervals.

Prognosis.—This should always be guarded, owing to the possible dangers and complications that often attend nephrolithiasis. Thus the passage of gravel without marked symptoms tends to persist or recur—in both events an unfavorable tendency, since subsequent formations are apt to be larger and cause serious symptoms. An attack of renal colic may itself be fatal. Large latent calculi, of long standing, lead, in most instances, to such grave complications as pyelonephritis, pyo- and hydronephrosis, perinephric abscess, and uremia.

Treatment.—Paroxysms of renal colic call for prompt relief. This is best afforded by hypodermic injections of morphin and atropin, coupled with hot baths or fomentations applied to the loins. The free use of hot drinks, as lemonade, soda, or plain water, is also helpful in promoting the passage of the stone. Cases of excessive suffering require the inhalation of chloroform.

The treatment of the nephrolithiasis without or between attacks of renal colic is most important. First to be considered are the **hygienic** and **dietetic** measures, for in mild and uncomplicated cases much can be done to prevent the aggravation of the disorder, and at least the formation of larger concretions may be delayed. The patient should live a regular, calm, steady, and temperate life. Exercise should be so managed that it may be taken rather moderately in the open air, and with a view to preventing additional weight in persons of fair nutrition and to promoting a reduction of weight in the obese.

Overindulgence in food, particularly in meats (liver, sweetbread, and similar nuclear food), should be prohibited. Alcohol should not be taken. On the other hand, since the urine is apt to be scanty, the patient should be encouraged to drink freely of plain and alkaline waters. The value of various pure spring-waters as diluents is undoubted, the Buffalo, Londonderry, and Otterburn Lithia, the Saratoga, Bedford, and Poland waters, all being distinguished for their purity. More marked and more generally useful for their alkalinity are the Carlsbad, Vichy, and carbonated waters. In cases characterized by occasional hematuria the Rockbridge alum-water may be tried. Plain soda-water and lemonade may be used as adjuvants.

The medicinal treatment of nephrolithiasis is aimed to secure a solvent and disintegrating action upon the stones; it is symptomatic. It is extremely doubtful whether stones once formed in the pelvis of the kidney and remaining there are ever dissolved. Lithium citrate or carbonate in 5-grain (0.3) doses in tablet form, three or four times daily, has been generally employed. Sodium phosphate and the vegetable salts of potash, as the citrate, acetate, and tartrate, are useful. Much water, especially the carbonated, should be drunk, along with doses of the above, and in this way relieve, in a measure, the local distress and pain.

The reaction of the urine must be tested at stated intervals and kept faintly acid if the stones are composed of uric acid. Should the urine become alkaline, the alkaline treatment must be suspended for a while, or a secondary deposit of phosphates about the uric-acid stone may be induced. Naggling lumbar pains may be relieved by occasional doses of such analgesics as acetphenetidin, belladonna, hyoscyamus, codein, and indirectly by the sweet spirits of niter.

Efforts to acidify the urine are indicated when the calculus happens to be composed of phosphates or of calcium oxalate. This is more difficult of accomplishment than when it is necessary to reduce the acidity. Saccharin in 2- or 3-grain (0.13–0.2), and benzoic and boric acids in 5- to 15-grain (0.3–1.0) doses, in capsules, seem to be most useful for this purpose. It is claimed for calcium carbonate, again, that it diminishes the phosphates without making the urine alkaline.

The question of surgical interference must be decided in not a few cases; thus, it may be briefly stated that in protracted and obstinate cases of calculous renal disorder, with persistent local pain, a gradually decreasing capacity for work, and evidences of severe pyelitis, pyelonephritis, or, worse, of perinephric abscess, the surgeon must operate. In the simplest cases a nephrotomy or nephrolithotomy may be performed and the stone removed. Where the renal structure is much damaged it may be necessary to do a nephrectomy. To avoid the increased perils of the latter operation, however, it were better that a nephrotomy were done as early as consistent with the diagnosis of incarcerated pelvic stone and the condition of the patient.

ACUTE NEPHRITIS

(*Acute Bright's Disease; Acute Diffuse Nephritis; Acute Parenchymatous Nephritis; Exudative, Catarrhal, Tubal, Desquamative, and Glomerulonephritis of Acute Course*)

Definition.—An acute inflammation of the kidneys, more or less diffuse in nature. It may be either of a mild, severe, or grave character. Delafield describes three varieties of acute renal inflammation under the common synonym of acute Bright's disease, as follows: (1) *acute degeneration of the kidneys*, (2) *acute exudative nephritis*, and (3) *acute productive nephritis*. At present writing the three forms following are recognized by many writers: (a) Acute tubular; (b) acute glomerular, and (c) acute diffuse nephritis. The last-named variety manifests the symptoms of the first two. Moreover, it is not possible to recognize clinically either acute tubular or acute glomerular nephritis in many instances, but I shall incidentally give a brief description of the morbid changes and clinical features which they present.

Pathology.—From the very mild to the gravest cases of nephritis there is an intermediate series of continuously more marked pathologic changes in the renal tissues. These depend greatly on the amount of poisonous material circulating in the kidneys and eliminated by them.

nephritis occurring as a complication of the infectious fevers, except scarlatina, may be characterized by the very slight degree, or even by the absence, of dropsy. Albuminuria, hematuria, anemia, and uremia supervene in the graver affections; this is the *acute tubular nephritis*. In *scarlatinal nephritis* we have an illustration of *acute glomerular nephritis*; anasarca is common, and slight edema at least is quite constant, while the blood-pressure is decidedly elevated. During the period of convalescence tube-casts (granular or fatty granular) may be found in the urine (Fig. 57). In mild affections simply a little albumin and a few hyaline casts reveal the parenchymatous degeneration. In cases of *degenerative nephritis* due to mineral poisoning the subsidence of the acute toxic symptoms may be followed by the *typhoid condition*. The *nephritis of pregnancy* is usually gradual in its onset, and the albumin increases from month to month. Some hyaline or faintly granular casts are found (Fig. 59), and erythrocytes rarely appear in the urine. *Danger of eclampsia* is constant until the albuminuria has subsided.

Acute productive nephritis (Delafield), in which there is a tendency to the formation of patches or wedges of fibrous tissue, is characterized by higher fever, by cerebral and circulatory disturbances of a typhoid nature, and by anemia, dropsy, and a highly albuminous urine, even though blood may be absent and casts may be few. The dropsy is most apparent in the legs. Dyspnea, vomiting, diarrhea, and a progressive and rapid loss of flesh and strength ensue until convulsions or coma, sometimes preceded by acute maniacal excitement, end in death. Milder cases, lasting from two to four weeks, apparently get well, albumin and casts persisting, however, until, after an interval of weeks or months, another and similar attack occurs. In short, the first acute attack is liable to chronic repetition until a fatal one takes place.

Diagnosis.—The condition cannot be overlooked when the urine is carefully examined both chemically and microscopically. The dreaded *eclampsia gravidarum* can, however, be recognized only by repeated urinary examination, especially during the last months of pregnancy. Acute Bright's disease should be suspected, and the urine examined in every case showing pallor of the skin and puffy eyelids, whether general prostration of the health is apparent or not. The characteristic symptoms of acute diffuse nephritis are the following: headache, restlessness, muscular twitching, dyspnea, nausea and vomiting, a tense pulse, moderate fever, dropsy, and anemia. Tube-casts and albuminuria are almost constant except in rare instances of puerperal eclampsia (J. Hirst). It should be borne in mind that slight albuminuria occurring in the course of pregnancy or during any of the acute specific fevers, *without casts*, is not a true nephritis, although a more or less remote consequence of the gradual degeneration of the renal epithelium associated with the febrile albuminuria. In addition to the presence of albumin and hyaline and cell-casts, however, a diminished quantity of sooty looking urine and the discovery of red and white blood-corpuscles will render the diagnosis positive. The history of the case and the causal factors are also to be taken into consideration.

The diagnosis of the particular subvariety is sometimes possible. Thus *acute tubular nephritis* commonly results from an intoxication, or more rarely from a severe infection or chilling. The urine is scanty, turbid, and often reddish brown in appearance, and the sediment is composed largely of renal epithelium and tube-casts. Edema is absent. The effects of the toxic agent on other viscera is shown by the presence of jaundice, myocardial weakness, and the like. In *acute glomerular nephritis* the urine is scanty, the amount of albumin large, but few if any tube-casts and renal cells are found. General edema is commonly present.

*Trench nephritis*¹ begins with the occurrence of edema and the presence of dyspnea. The peculiarities of this subvariety have been epitomized by Sir John Rose Bradford² as "rapid subsidence of well-marked renal dropsy; frequent presence of bronchitis and dyspnea; severity and suddenness of onset of uremic manifestations, such as epileptiform seizures; rarity of occurrence of inflammatory complications, and an extraordinarily low mortality."

Tytler and Ryle³ have made a very complete report on this disorder from study of 150 cases, with 25 autopsies. The patients who died presented clinical evidence of death from respiratory failure from pulmonary edema. The most characteristic findings at necropsy were found in the lungs and the spleen. The lungs showed extensive pulmonary edema together with a purulent bronchitis, while the spleen showed hemorrhagic lesions. The kidneys grossly presented only the most slight changes, which were shown to be inflammatory changes in the glomeruli when studied microscopically. The lungs microscopically showed evidences of a well-marked inflammatory reaction which the authors consider the predominating change both clinically and anatomically. In regard to the etiology of the condition Tytler and Ryle were able to culture from the urine of 24 out of 40 cases streptococci of the fecal type.

Prognosis.—The *duration* of ordinary exudative or tubal nephritis following exposure to cold and wet varies from a few days to three, four, or six weeks. The albuminuria steadily decreases, and with the casts finally disappears, while the daily quantity of urine increases, as does the excretion of urea. The prognosis depends much upon the primary disease or causative condition, and also upon the intensity and character of the renal inflammation. Scarlatinal nephritis is less likely to be recovered from than nephritis due to exposure to cold after alcoholic excesses. The acute parenchymatous degeneration that accompanies typhoid fever, diphtheria, and other infectious fevers, as well as pregnancy, is usually a mild affection and recovery takes place easily. But in acute yellow atrophy, yellow fever, cholera, and in severe phosphorus- or mercurial poisoning death may occur from the intense and wide-spread necrosis of renal epithelium. In favorable cases of ordinary exudative nephritis the dropsy and albuminuria gradually diminish, while the color of the skin and the quantity of urine and urea increase, so that in the course of from three to four or six weeks recovery is established. After the disappearance of the dropsy the albumin may persist for some time, and then slowly disappear; but rarely, in unfavorable cases, even when dropsy has disappeared, albuminuria may continue and the affection become a chronic parenchymatous nephritis.

Serious and often dangerous symptoms of acute nephritis are: severe general edema, dropsical effusions into the serous sacs (as hydrothorax), uremia (especially when beginning with cerebral manifestations, as coma or convulsions), and finally inflammation of the internal organs, as pleuritis, pneumonitis, pericarditis, peritonitis, and meningitis. In the absence of uremia recovery in cases of marked general dropsy is quite common. Suppression of urine, however, lasting more than twenty-four or forty-eight hours, is usually a fatal symptom. The prognosis is unfavorable also in cases in which the nephritis has a productive character. Life may, on the other hand, be prolonged for several years.

The various functional tests, according to Rowntree, are of little prognostic value on account of the rapidity with which marked changes in this respect occur. Such tests should be frequently repeated to get much information from them. An absence of phthalein for several days and a high blood urea

¹ For complete article see *Quart. Jour. Med.*, 1918, xi, 112; *Jour. Amer. Med. Assoc.*, 1918, lxx, 998.

² *Jour. Amer. Med. Assoc.*, June 24, 1916, p. 2070.

³ *Quart. Jour. Med.*, 1918, xi, 112.

concentration are grave prognostic findings. In a series of cases reported by Stengel, Austin, and Jonas¹ which came to autopsy the kidney functional tests all showed a decided impairment.

Treatment.—I shall not include here the management of the primary affection of which the nephritis may be either a complication or consequence. Bland *foods* only should be allowed in the acute stage. Proteins should be limited. For this reason von Noorden gives thin gruels, fruit juices, and sugars, withholding milk for a week or two until the more acute symptoms have subsided. Salt is interdicted and water or fluids should be taken moderately, as they entail more work on the kidney, particularly if edema is present. Gradually the diet may be increased by adding milk, a quart in the twenty-four hours, junket, custard, vegetable purées, crackers, cocoa, and so on. Water can be given in increasing quantities when the urine is being freely passed. Fischer gives alkaline solutions (sodium chlorid, 14 gm.; sodium carbonate, 15 gm.; aqua dest., 1000 c.c.) by mouth, by rectum, or, in severe cases, intravenously, on the supposition that the nephritis is a manifestation of acidosis.

Since the renal function is diminished by the congestion and inflammation, the first object in the treatment is to relieve these conditions and thus restore the excretory function. The single or combined use of diaphoretics and cathartics is practised, therefore, not that the skin and bowels should be made to perform the work normally done by the kidneys, but in order to restore the functional equilibrium by the antiphlogistic effect produced.

Absolute rest in a warm bed and in a warm room is of primary importance. Woolen underwear and blankets should be provided, so as to promote a constant free action of the sweat-glands. These hygienic measures should be carried out both in the mild and in the severer cases.

Local bloodletting, as by leeches or cupping over the loins, I seldom employ; in rare cases, however, when much pain is complained of, it may be useful, although hot fomentations may be more so. Diminution of the edema and the elimination of urea and other urinary constituents that may be retained in acute nephritis are best obtained by exciting a profuse perspiration. The hot-air or hot-water bath and the hot wet-pack may be used to accomplish these results, and in most cases the last-named method suffices. It is easily applied by wringing a blanket out of hot water, wrapping the patient in it, and then with a dry blanket, and finally a rubber-cloth cover, surrounding all. This furnishes a steam-bath in which the patient may remain until copious sweating has lasted an hour or so, according to the condition. Children suffering from scarlatinal nephritis may be treated thus, or quite readily also by immersion in hot water, for twenty, thirty, or forty minutes; the skin should then be lightly dried, and the child wrapped in warm sheets or blankets and warmly covered in bed. Hot vapor or air may be generated alongside the bed, and transferred under the raised or cradled bed-clothes by means of a tin funnel and pipe. The sweating will be aided by the drinking of hot lemonade or soda-water or of water containing spirit of mildererus. Should the skin fail to respond to these measures, as in uremia, perspiration may be started by a hypodermic injection of pilocarpin (gr. $\frac{1}{8}$ to $\frac{1}{6}$ —0.008–0.0108), after which it will continue to pour out on the application of heat. The heart and pulse should be watched after the injection of pilocarpin, as serious collapse sometimes attends its use. The sweatings should be repeated until the dropsy disappears and as often as the patient's strength will permit. The beneficial effects of sweat-baths are not due to the removal of nitrogen through the skin, but rather of sodium chlorid. A useful adjunct to the above is the administration of hydragogues, as the saline cathartics, elaterium, and compound jalap powder. Elaterium extract (gr. $\frac{1}{8}$ to $\frac{1}{4}$ —0.0108–0.0162) is prompt in action, and mag-

¹ *Arch. Int. Med.*, 1918, xxi, 313.

On section the cortex is broader than normally, yellowish white throughout, or it may present opaque yellowish or whitish areas with mottlings of red. The pyramids are congested in some cases. Microscopically, the renal epithelium is swollen, hyaline, granular or fatty, and more or less disintegrated or flattened; the glomeruli are enlarged from the growth of the capsule-cells and of the cells covering the capillaries, and in some cases, owing to the connective-tissue thickening of the capsule, the tuft of capillaries is found to be atrophied. The interstitial tissue shows some thickening of the arterial walls and a moderate growth of connective tissue in patches around the glomeruli and tubules; the latter contain hyaline and granular casts.

The *small white kidney*, or secondary contracted kidney, in most instances is probably a later stage of the preceding, in which the degeneration of epithelium is more advanced and the growth of connective tissue and resultant cicatricial contraction are prominent features. The surface is slightly granulated, and the capsule is proportionally adherent. While this kidney is usually grayish or yellowish in color (*pale, granular kidney*), there may be some mottling due to red spots. The consistence is firm and the cut surface shows yellowish-white foci of the fatty degenerated epithelium in the narrowed cortex, "small, granular, fatty kidney." Under the microscope we find extensive degeneration and disintegration of the epithelium of the glomeruli and convoluted tubules, with atrophy of the parenchyma, and a corresponding increase of the interstitial connective tissue. Waxy degeneration may be associated.

Another variety is the *large red or variegated kidney of chronic hemorrhagic nephritis*. The organs are usually enlarged, swollen, red, and congested looking or mottled, and frequently "bumpy" or slightly bossellated. The capsule is slightly adherent to the depressions between the bosses. Red spots, due to small hemorrhages, may be noticed. The section shows also congested portions and gray or yellow spots corresponding to the anemic and fatty degenerated portions. Small cortical hemorrhagic areas or striations, brownish-red in color, are distinctive of the kidney. The microscopic appearances are those of the large white kidney plus those of acute nephritis. Or, there may be inflammatory edema and cellular infiltration of the intertubular tissue, and dilated tufts of capillaries with surrounding cellular hyperplasia.

Etiology.—The disease may follow either the acute diffuse nephritis, as of scarlet fever or pregnancy, or simple chronic congestion and chronic degeneration of the kidneys. Watson believes that acute nephritis is not a common disease, is usually due to the direct effect of some infection and that the majority recover completely. More often chronic parenchymatous nephritis arises insidiously, in a subacute manner and without any previous acute manifestation. Males are more frequently subjects than females. Children affected with the disease have usually had scarlatinal nephritis. Young adults are more commonly affected, however, with the usual variety, developing subacutely. Drinkers of beer and other malt and alcoholic intoxicants seem to be liable to the disease. It is not improbable that some toxic or infectious agency, acting slowly and persistently, may in the insidious cases be the cause of the nephritis, although manifestations elsewhere may be absent. I have observed it in certain individulas living in malarial regions. Persons working under exposure to cold and wet, and those living in humid and low, marshy localities are more liable than those who are better protected from climatic vicissitudes. Tuberculosis, syphilis (8 out of 84 cases—Stengel and Austin), and chronic suppuration may give rise to the "parenchymatous" form of chronic Bright's disease, and it is usually combined with amyloid disease.

Symptoms.—There may be a persistence, in a lesser degree, of the symptoms of an acute parenchymatous nephritis, particularly the anemia, dropsy,

albuminuria may attack one who for years previous has had apparent good health, after a first attack the second proving fatal within a few months. Again, some patients, having a little pallor, urine of high specific gravity, with albumin, may complain of nothing for years, until decided attacks, lasting for several months, may occur, with intervals during which the dropsy, dyspnea, etc., may be absent, although some albuminuria persists. The average *duration* of the disease varies. The duration of chronic hemorrhagic nephritis may be somewhat longer (eight months to two or three years) than that of the large white kidney (six to eighteen months), but it is shorter than the secondary contracted kidney, which lasts from one and a half to three or even five years.

The **diagnosis** of the disease itself is not difficult, but of the stage or the variety of kidney it is almost impossible to tell correctly in some instances. The urinary examination, coupled with the symptoms of dropsy and anemia, is sufficiently diagnostic of chronic diffuse nephritis (with exudation). The phenolsulphonephthalein output is uniformly low (Thayer and Snowden).

In cases of *large white kidney* the urine passed is, as a rule, less in quantity and is of higher specific gravity than in the small, pale, and contracted kidney. Edema is usually greater in the former also, while in the latter cardiovascular changes are more marked. The transition of the disease from the earlier to the later stage may be thus noted. The casts in the latter may be narrower and more darkly granular than in the large white kidney. The existence of *hemorrhagic kidney* may be inferred from the history of alcoholism and the persistent presence of erythrocytes and blood-casts in the urine.

Chronic parenchymatous is distinguished from chronic interstitial nephritis by the following points of difference:

CHRONIC PARENCHYMATOUS NEPHRITIS

Occurs in early or middle life.

There is a previous history of an acute attack, of scarlet fever, or perhaps of acute alcoholism.

The onset is gradual or markedly manifest.

Dropsy is a constant symptom.

Vascular changes and cerebral symptoms are comparatively uncommon.

Albuminuric retinitis common.

Marked albuminuria; many tube-casts, chiefly short, thick, granular.

Urine but little increased in quantity, often diminished; specific gravity is increased or slightly diminished.

Anemia occurs earlier and is marked.

Uremic symptoms are generally less severe—amaurosis, vomiting, diarrhea, headache.

Runs a shorter course—from two to six or seven years.

CHRONIC INTERSTITIAL NEPHRITIS

Occurs later in life.

A previous history of gout, chronic lead-poisoning, syphilis, excessive eating and drinking (spirits), nerve strain.

The onset is very slow, insidious, and indefinite.

Dropsy is rare.

Arteriosclerosis, cardiac hypertrophy, and cerebral symptoms are common.

Retinal hemorrhage and choking of disk.

Very slight albuminuria and few casts, chiefly hyaline (long, narrow).

Urine of very low specific gravity and excessive in quantity.

Anemia slowly progressive and less marked.

Uremic symptoms are generally severe—coma and convulsions, great dyspnea.

Has a more chronic course—seven to thirty years.

Prognosis.—This is invariably bad as to cure, though life may be prolonged in certain cases. In severe cases death may take place in from three months to a year, either from uremia, dropsy, cardiac dilatation, or complications. Cases of a year's duration almost never recover, and, *a fortiori*, those in which advanced secondary contraction of the kidney may be inferred are incurable, and may soon terminate fatally. Complete recoveries from the disease, particularly in children that have had scarlet fever, may occur but rarely. The prognosis depends greatly on the quantity of urine passed daily, the excretion of urea and total solids, and upon the amount and persistency of the albumin, as well as upon the degree of cardiovascular and retinal changes.

(b) arteriosclerotic kidney; (c) the senile type, and (d) the secondary form (small white kidney), which was described under Chronic Parenchymatous Nephritis, of which it is a sequel.

(a) In the primary form, or true red granular kidney, these organs are often exceedingly small, and both kidneys together may not weigh over 2 to 4 ounces. The capsule is thick and very adherent, tearing the substance as it is stripped off, the surface reddish-brown in color, finely granular, and cysts may be numerous. The consistence is dense and resistant to the knife, the cut surface showing a thin atrophied cortex and sclerotic arteries. In the gouty kidney the pyramids show fine striations of sodium urate, or of uric acid or crystals representing uric-acid infarctions. The tubules show marked changes. Some are included in masses of connective tissue, so that there is compression atrophy and even total obliteration of the lumen. The inter-tubular connective tissue constricts the tubules in certain places, so that the lumen is elsewhere increased. The epithelium lining these tubules shows granular, fatty, or waxy degeneration, and may be either flattened, cuboid, or swollen. The tubes may contain granular or fatty debris and tube-casts.

(b) The arteriosclerotic kidney, like that of (a), is red and dense, but unlike the latter is not greatly reduced in size, and is often heavier than normal. The capsule is only slightly adherent, but little thickened, and the surface smooth. In certain cases circumscribed, depressed areas, red in color, due to localized atrophic changes, may be observed. The cut surface presents a reddish-brown color and arteriosclerotic vessels (obliterating endarteritis).

(c) The senile form is attended with reduction in the size of the kidney, with increase in the pelvic fat. The capsule is thick and adherent, the arteries sclerosed, and both the cortex and pyramids decidedly atrophied.

An almost constant accompaniment of chronic productive nephritis is cardiac hypertrophy. The degree of the latter depends upon the extent of the renal, and also of the general, arterial sclerosis. The whole heart may become so large that the term *cor bovinum* has been fittingly applied to it. In moderate enlargements the left ventricle only is hypertrophied.

Complicating lesions that may be mentioned are cerebral hemorrhage, cirrhosis of the liver, pulmonary emphysema, chronic endocarditis, chronic endarteritis, pericarditis, bronchitis, and gastric catarrh.

Two leading views on the question of the relation of the renal changes to the associated arteriosclerosis and cardiac hypertrophy: (a) The mechanical and (b) the chemical. Bright first suggested the mechanical theory, and since then Sir George Johnson, Senator, Traube, Cohnheim, Tyson, and others have advocated it. According to this view, the primary atrophic and degenerative changes of the renal parenchyma are compensated by a secondary rise of blood-pressure followed by cardiac hypertrophy and arteriosclerosis. Obviously, to compensate the loss of renal function due to the local lesion demands increased force on the part of the left ventricle, thus engendering hypertrophy and an exalted blood-pressure throughout the uninvolved portions of the kidneys as well as the general arterial system. The arteriosclerosis, however, may be primary, as in the arteriosclerotic kidney. Again, the vascular and renal conditions may develop independently of one another, although dependent upon a common cause.

(b) The *chemical theory* assumes the production, either by the kidneys or suprarenal glands, or both, of certain pressor substances, or the retention of toxic substances, which are capable of raising the blood-pressure, the latter in turn eventuating in hypertrophy of the heart and sclerosis of the arteries.

Etiology.—The cause of the slow diffuse degeneration, atrophy, and fibroid contraction of the kidneys is sometimes quite obscure. (a) In some cases it would seem to be “only an anticipation of the gradual changes which take

affection until death results from sheer feebleness and emaciation. The complexity and variability of the symptoms make it best to describe them under the heads of the various systems:

Urinary System.—The daily *quantity of urine* is usually increased so much that patients are troubled with a desire to urinate frequently not only during the day, but two or three times during the night. This complaint may be aggravated by the hyperacidity of the urine and the irritability of the prostate (especially in advanced age) that are so often associated with cases of renal cirrhosis. The urine voided during the twenty-four hours may measure several quarts (2 to 4 liters) in well-marked cases of the disease. Early in the attack, when the incipient degeneration and destruction of the parenchymatous cells is taking place, the quantity of urine may be slightly decreased; but as the "blood-flow to the parts that remain must, *cæteris paribus*, be as great as it would have been to the whole of the organs if they had been intact," excessive pressure is brought to bear within the capillaries by the compensating hypertrophy of the heart, and the secretion of the urine, especially of the watery elements, becomes more active. The *polyuria* may give rise to a suspicion of diabetes. The urine is clear and pale yellow in color, the *specific gravity* being seldom above 1010 or 1012, and it may be as low as 1002 or 1005. *Albumin* is found only in traces or it may be absent altogether (*glomerular atrophy*), especially in urine voided in the early morning. The urea is diminished, and there is little or no sediment. Widal classifies the cases of nephritis into those with retention of salts and those with retention of nitrogenous substances in the blood. He claims that the determination of urea in the blood, as contrasted with examination of the proportion of nitrogen in the urine, is more important clinically than the estimation of the percentage of albumin in the urine. A very careful microscopic examination may reveal a few, usually *narrow, hyaline or granular casts*, and rarely a few *erythrocytes*. In the later stages of the disease or upon the supervention of an uremic exacerbation or of a complicating inflammation the urine may be decreased, the albumin increased, and numerous casts be discovered in a more apparent urinary sediment. Hematuria is rare.

Circulatory System.—The freezing-point of the blood is lowered, due to the retention of products normally eliminated by the kidneys. It is to be recollected that the freezing-point in health is -0.56° C., and in nephritis it may be found to be -0.58° C. or lower. The *physical signs* of cardiac hypertrophy are present. Symptoms referable to the heart are absent unless dilatation and feebleness, sudden arterial contraction, cardiac complications, or endocarditis occur. *Inspection and palpation* of the *hypertrophied heart* show apex-beat displaced downward and to the left, and an increased, heaving, and rather circumscribed apical impulse. These signs may be less evident in cases of coexisting emphysema. The left border of the deep cardiac dullness extends outside the nipple-line in the fifth or sixth interspace. The first sound of the heart is loud and may be duplicated. A distinctive auscultatory sign is the *accentuation of the aortic second sound*, indicating increased vascular tension. In quite a majority of the cases I observe, sooner or later, a mitral systolic murmur; it is due to relative insufficiency.

The *pulse is increased in tension*, and is hard, incompressible, and persistent, the duration of each pulse-wave being increased (*pulsus tardus*). The radial artery itself—and this is true of most of the palpable arteries—feels hard, thickened, and often tortuous, on account of the arteriosclerosis. The systolic blood-pressure is decidedly high, often exceeding 200 mm. Hg. As soon as compensation of the heart fails, symptoms of breathlessness (especially on exertion), palpitation, and the like, appear, and sometimes in paroxysmal

The Skin.—Edema is usually absent in renal sclerosis; when it does occur, however (as in the ankles and limbs), it is due to dilatation and failure of the heart. The skin is dry; a certain degree of pallor is noticed, and often it has a cyanotic tinge. *Pruritus* and troublesome eczema are frequently present, and *muscular cramps*, occurring especially in the calves of the legs and at night, may also be associated. The general nutrition gradually fails, so that in advanced cases the debility and emaciation are extreme.

Uremia may come on at any time during the course of the disease, and may be the first symptomatic manifestation; it may either be sudden and severe in its onset (acute uremia), or mild, insidious, and gradual (chronic uremia). Moderate fever may attend a uremic attack, or the temperature may be normal; in chronic uremia, with prostration, coma, delirium, and feeble pulse, it may be even subnormal.

Among the **complications** that may occur are the following: pneumonia, either lobar or lobular; pleuritis, pericarditis, bronchitis, gastritis, enteritis, peritonitis, meningitis, endocarditis, emphysema, phthisis, acute dermatitis exfoliativa (Duckworth), and hepatic cirrhosis.

Diagnosis.—This depends in great part upon the physical, chemical, and histologic examination of the urine. Both the morning and evening urine should be examined repeatedly for albumin and casts, since one examination—and especially that of the morning urine—may give negative results, owing both to the scarcity of these two pathologic elements and to the fact that one or both may be altogether absent in some instances. The mere discovery of a trace of albumin or of a few casts is not always positive evidence of chronic Bright's disease, as both may exist in other conditions. But the age, habits, and symptoms of the patient must be studied in connection with frequent urinary examinations; and a persistent slight albuminuria, with casts, and the passage daily of large quantities of clear, pale urine of low specific gravity, afford sufficient grounds for making the diagnosis. The test-meal for renal function (*vide* p. 956) probably gives the earliest indication of diminished kidney efficiency (Mosenthal and Lewis).

Contracted kidney should be suspected in all cases in which, during middle life, either one or more of the following symptoms and signs may be noticed: frequent headache, congestive disorders, repeated epistaxis, vertigo, dimness of vision, intractable conjunctival irritation (Alleman), impaired strength, dyspneic attacks, gastro-intestinal dyspepsia, noises in the ear, itching of the skin, cramps in the calves, muscular twitchings, growing mental dulness, increasing pulse-tension, and rigidity and tortuosity of the temporal and radial arteries. Sudden coma, convulsions, amaurosis, apoplexy, vomiting, or dyspnea in persons in the middle period of life, with or without a history of polyuria should create the suspicion of chronic Bright's disease. It will be found in such cases that there has been a diminution in the urinary flow before the attack. Persons of gouty, rheumatic, or alcoholic habits, with evidences of cardiac hypertrophy, an accentuated aortic second sound, and a hard pulse are often readily diagnosed as subjects of contracted kidney when an examination of the urine is made.

If the first examination of the patient is made during a sudden uremic or apoplectic attack, catheterization should be done if necessary, and the detection of albuminuria will then clear the diagnosis.

In order to differentiate between primary renal affection with secondary cardiac hypertrophy and *primary heart disease with a secondary congested kidney occurring late in the case*, the general features, course, symptoms, and signs must be carefully and judiciously balanced. Prominent cardiovascular changes would indicate an arteriosclerotic kidney. The presence of a diastolic

murmur would tend to exclude primary contracted kidney of toxic origin; on the other hand, an albuminuric retinitis would point to a primary renal complaint. The symptoms of ordinary non-inflammatory *senile kidney* may not be unlike those of chronic interstitial nephritis, though not so severe; and yet, from excessive eating and drinking at times, uremic attacks may supervene to cloud the diagnosis.

Prognosis.—The *duration* of chronic interstitial nephritis varies. In uncomplicated cases it may last for five, ten, twenty, or possibly thirty years. Complications or intercurrent affections may, however, shorten the duration very much. Janeway, in a study of 122 private patients whose records extended over a long period of time found that 60 died as a result of gradual cardiac insufficiency; 46 of uremia; 29 of cerebral apoplexy; 10 of angina pectoris; 7 of pulmonary edema; 13 of complicating acute infectious disease; the remainder of various infrequent complications or accidents. The *postmortem* examination may show the characteristic kidneys in one who during life had no symptoms indicating renal disease, and whose death was caused by some intercurrent disease. The gradual destruction of the renal parenchyma and its replacement by scar-tissue cause irreparable damage to the organs. On the other hand, the fact that the process is usually a slow one and its duration long is compatible with the preservation of life for many years, and with comparative comfort, even, in many instances. The prognosis in a given case depends very much upon the general constitutional condition, the cardiovascular state, and the presence or absence of uremia and inflammatory complications. Cardiac dilatation and insufficiency indicate a not far distant end. It is in the prognosis of these cases that the various functional tests, as previously described, are of so much value. In the early stages of the disorder salt is excreted fully in the twenty-four hours, but the urine is of a low specific gravity and low salt concentration. Water excretion is accompanied by polyuria, nocturia, and a low specific gravity. As the renal insufficiency progresses the phthalein elimination becomes decreased, the blood urea increases, as does the uric acid. In the terminal stages phthalein may not be eliminated, the blood nitrogen reaches extremely high figures, salt is retained as well as lactose, and the specific gravity of the urine is fixed and constant. The blood creatinin may rise to over 5 mg. per 100 c.c. of blood as death threatens. Convulsive and apoplectic seizures are often fatal, and hemorrhages, persistent vomiting, and diarrhea, *retinitis nephritica*, coma, and delirium render the prognosis as to further systemic tolerance of the degenerated kidneys exceedingly grave.

Treatment.—An early recognition of the disease and the steadfast practice of careful hygienic measures will prevent, to a considerable degree, the advance of the cirrhotic changes. Noxious substances entering into the etiology of the affection must be avoided and removed as far as possible. Alcoholics must be interdicted, and lead—when the cause of the condition—must be kept from further poisoning the system by a change of occupation. By diminishing these irritants the heart and blood-vessels are also conserved—a point of vital importance.

The **hygienic treatment** must embrace a regulation of all the habits of body and modes of life. The patient must be treated, and not his malady, since that is incurable. A dietary that is suitable for each individual case must be made out; it must be the aim to maintain the nutritive equilibrium of the patient without producing irritation of the renal epithelium. Vaughan holds that a salt-free diet protects the kidneys by decreasing their labor. Saundby's rule is a good guide: "Eat very sparingly of butcher's meat; avoid malt liquors, spirits, and strong wines." Red meats are no more injurious than white in their effects in this disease. An exclusive milk diet may be necessary

for short periods when gastric irritation is present. Tervoert and van Lier claim that their experiments and clinical experience indicate that restriction to a milk diet in cases of nephritis with retention of urea is decidedly harmful. Von Noorden urges that milk contains, on the whole, too much protein, and recommends that it should be restricted to 3 pints a day, to which 1 pint of cream should be added. Vegetables, greens, fruits, and light, well-cooked farinaceous articles may also be partaken of, and cocoa may be drunk. The use of natural mineral waters aids in the renal circulation and keeps the kidneys flushed. In general, a mixed diet will be of advantage; the nitrogenous and carbohydrate elements (sugars and starches) are used in limited amounts, while pure fats and fruits (raw or cooked) are to be recommended. I would add that whole milk, diluted, should make up a considerable portion of the diet, that meats be allowed in small quantity once daily, as a rule, and that we should draw largely upon the vegetable kingdom for aliment. Stout persons and those leading sedentary lives should have less food than those taking exercise, and gastric disorder requires the elimination of all but soft, bland foods, or a liquid diet until digestion is restored. As elsewhere stated, it is impossible to lay down a dietary that would be suitable for all cases on account of the peculiarities presented by the individual cases. The effect of a given diet is to be noted by a careful observation of the bodily weight and by oft-repeated examination of the urine and blood. Extremes of bodily and mental activity should be avoided, and physical exercise should be moderate, regular, and taken in the open air, provided the latter be warm and dry.

A change of residence to a warm, mild, and dry climate is often of service. The variability and humidity of temperate climates, particularly during winter, aggravate this disease, while a sea voyage or a sojourn at some southern, western, or European resort, where the soil is dry and sandy and the climate equable, may be very beneficial.

The indications for **medicinal treatment** are principally as follows: The bowels should be kept free by the aid of laxatives (*e. g.*, trituration elaterini, gr. $\frac{1}{4}$ to j—0.016–0.065) or laxative alkaline mineral waters. Bitter tonics are useful in some cases in which a furred tongue and indigestion are troublesome. Acids or alkalies, according to special indications, may also be used simultaneously. An increased vascular tension, such as to place a serious strain upon the heart; the other extreme, of a very low tension, that induces dropsy; and complications, usually uremic (convulsions, dyspnea, headache), also call for therapeutic assistance. High tension is to be met by the cautious use of nitroglycerin in gradually ascending doses, beginning with 1 minim (0.065 every three hours. Headache, vertigo, and the so-called renal asthma (dyspnea) are also often relieved by this drug. A too great reduction in the arterial tension is undesirable, being attended with danger of uremia and serous effusions, owing to insufficient urinary excretion.

Low tension, with signs of cardiac dilatation, scanty albuminous urine, and edema, requires heart tonics and stimulants, in conjunction with purgatives. Digitalis (preferably in infusion) has good effects, especially when combined with strychnin nitrate. The salines should be given for the dropsy.

Uremic symptoms should be treated as in acute Bright's disease by causing profuse sweating and free catharsis, and in some cases by phlebotomy. Inhalation of amyl nitrite or chloroform, or, what is often a useful and necessary measure, the hypodermic injection of morphin (gr. $\frac{1}{6}$ —0.0108), may be tried in convulsions, severe headache, or dyspnea. White and Wilcox¹ have shown that morphin does good in nephritis by diminishing the oxidizing functions of the body metabolism. Le Fevre extols chloral for its more lasting action than chloroform.

Contracted kidney of a probable malarial or syphilitic origin may be benefited somewhat by the use of arsenic cautiously and the iodids respectively; but no drugs can possibly restore the destroyed renal parenchyma or transform connective-tissue cells into secreting kidney cells.

Certain recent writers (Rose, Ferguson, Wolff) had observed the disappearance of casts and albuminuria after the operation of nephropexy in which a portion of the capsule had been removed. In 1898 Edebohls first proposed the cure of chronic nephritis by operation—decapsulation. He reports 18 cases thus treated, and in each operation (except 2) stripped off about one-half of the capsule. The beneficial and curative effects indicated by an increased flow of urine and the disappearance of dropsy tube-casts and albumin, do not show themselves usually before the tenth day. It is not a helpful operation in advanced cases and its precise value as a therapeutic measure in chronic nephritis has not as yet been determined. While the majority of the cases treated surgically belong in the category of chronic interstitial nephritis, decapsulation is quite as appropriate in suitable cases of the parenchymatous variety.

PYELITIS

(*Pyelonephritis; Pyonephritis*)

Definition.—Inflammation of the pelvis of the kidney. The compound terms above represent inflammation of the kidney structure as a result of, and combined with, pyelitis.

Pathology.—In the mildest varieties of pyelitis (the catarrhal) the morbid changes consist simply of a reddened, swollen, and turbid mucous membrane, covered with an exudation of viscid mucopus and desquamated epithelium. Ecchymoses are sometimes seen. The urine in the pelvis of the kidney is also turbid from the admixed pus-corpuscles and pelvic epithelium. In calculous pyelitis purulent inflammation and ulceration prevail, and the kidney structure is also involved by extension (pyelonephritis). Renal abscesses are thus formed, and small dark calculi may be found mingled with the pus in small abscess cavities; or, perhaps, as noted before (*vide* Nephrolithiasis), one large abscess cavity may replace the destroyed renal parenchyma (*pyonephrosis*).

A diphtheritic inflammation, with the formation of a false membrane and sloughing of the pelvis, sometimes follows the severe acute infections. Marked hemorrhagic areas may be seen also. In tuberculous pyelitis there is usually an association of nephritis with areas of tuberculous softening and ulceration, and later pyonephrosis. In very chronic cases the pyelitis may be followed by an infiltration of the kidney structure with cheesy masses that may become the seat of calcification.

Persistent obstruction leading to pyelitis is associated with dilatation of the pelvis from retention of urine or of pus (pyonephrosis). This, in turn, from prolonged pressure, causes marked atrophy of the secreting structure of the kidney. There is also an increase in the interstitial tissue. Herbst¹ has emphasized the frequency of acquired stricture of the lower end of the ureter as a cause of obscure affections of the kidney. The so-called *surgical kidney* is found when an acute bilateral pyelitis, following a severe cystitis, has excited an acute suppurative inflammation of the kidney. Acute suppurative or interstitial inflammation of the kidney due to metastatic or miliary abscesses is considered under the heading *Pyemia* (*vide* p. 168).

Etiology.—Pyelitis rarely is primary or independent in origin, as after

¹ *Jour. Amer. Med. Assoc.*, November 23, 1918, p. 1722.

posure to cold and wet. The principal organisms concerned are the *colon*, *staphylococcus*, *streptococcus*, and *gonococcus*. The secondary causes of pyelitis are as follows: (1) renal calculi (the most frequent); (2) extension upward through the ureteral lymphatics of the organisms causing urethritis or prostatitis; (3) retention of decomposed urine in the pelvis of the kidney; (4) local affections, as tubercle, carcinoma, and acute nephritis; (5) specific fevers; (6) foreign bodies, other than stone in the pelvis; (7) irritating diuretics. To put out briefly certain additional facts bearing upon the causation of pyelitis in the order named, it should be mentioned that *calculous pyelitis* may result from the irritation of the constant presence and passage of small stones ("ravel"), or even of uric-acid "sand," as well as from the large dendritic concretions that send offshoots into the calyces. Extensions of inflammation from the pelvis from lower portions of the urinary tract may occur in protracted cases of such affections as gonorrheal urethritis and puerperal and calculous cystitis. The preponderance of right-sided pyelitis has recently been explained by the finding of a direct lymphatic connection between the colon and the right kidney (Franke). *Obstructive pyelitis* sometimes follows the impaction of renal calculi or of other foreign bodies in the ureter when there is pre-existing inflammation of the tract, or when, as usually happens, there is chemical irritation from the decomposition of the accumulated urine. There may be obstruction in the bladder and urethra, as from enlarged prostatic tumors, stricture, phimosis, and paralysis of the sphincter vesicæ, or as in paraplegia. When the consideration of tuberculosis and carcinoma of the kidney is included, the involvement of the pelvis by these conditions. *Infectious pyelitis* may result from small-pox, diphtheria, typhoid fever, and scarlatina, and it depends upon the presence of the organisms in the blood-stream. It is usually associated with more or less nephritis (pyelonephritis). Parasites, such as the *hydatid* (hydatids), *distoma*, *strongylus*, and *filaria*, may give rise to pyelitis. Cantharides, cubebs, copaiba, turpentine, and diabetic urine even, rarely excite a pyelitis in association with pyogenic bacteria.

Symptoms.—These are frequently overshadowed by those of the primary causative condition: they are varied also for the same reason. The clinical manifestations of a simple catarrhal pyelitis are slight pain and tenderness in the region of the affected kidney or kidneys, mild fever, with a *turbid urine* and *acid reaction*, showing a few pus-cells, a little mucus, rarely some red blood-cells, and a trace of albumin.

In the severer varieties, as in calculous pyelitis, especially when there are attacks of renal colic, the urine frequently shows to the naked eye the presence of blood and a marked amount of *pus*, some *mucus*, and at times the transitional *late epithelial cells* from the middle layers of the mucosa. In obstructive pyelitis the urine sometimes flows freely and normally for a while, until the increasing pain over the inflamed kidney ends in relief by the expulsion of the stone and the passage of purulent urine. This *alteration* of normal with turbid urine is indicative of a unilateral pyelitis. *Ammoniacal urine* is met with in *cystopyelitis*. *Albuminuria* is decidedly shown according to the degree of pyuria.

In chronic suppurative pyelitis or pyelonephritis the pyuria is variable in quantity and constancy. *Intermittent pyuria* may be due to the temporary blocking of the ureter by a stone (*vide* Obstructive Pyelitis). The urine is seldom mixed with epithelium in chronic purulent pyelitis. The associated intermittent fever may be like that of tuberculous pyelitis, and marked emaciation, anemia, and emaciation are concomitants. Evidences of amyloid degeneration may be revealed in long-standing chronic cases.

In severe pyelitis the *pain* is often acute, coursing *down the ureters*. The

Based on a thorough analysis of a considerable number of non-tuberculous renal infections, Cabot and Crabtree¹ state that, if with clinical evidence suggesting a renal infection, freshly drawn urine shows cocci in abundance with a small amount of albumin, a few red blood-corpuscles and many leukocytes or a little pus, together with a renal function at or near normal limits, a diagnosis of coccus infection of the kidney is justified. If, on the other hand, a similar examination shows many bacilli, a little albumin and much pus, with a markedly diminished kidney function, a diagnosis of colon bacillus infection of the kidney is unavoidable.

Difficulty is sometimes experienced in diagnosing pyelitis when co-existent with cystitis—*pyelocystitis*. These affections will not be confounded, however, when it is recollected that their histories differ. There is pain in one lumbar region in the former, and in the bladder in the latter.

According to Rosenfeld: (1) an alkaline reaction is not found in uncomplicated pyelitis; (2) the limit of albumin in the urine, even with severest cystitis, is 0.1 per cent. (maximum, 0.15). Stress is laid upon the relation of the albumin contents, which is from two to three times greater with pyelitis than with cystitis.

Prognosis.—Renal complications always make the pyelitis a serious affection. Catarrhal cases recover. Calculous pyelitis tends toward chronicity. Pyelonephritis and pyonephrosis are apt to end fatally from exhaustion or uremia. Perforation and the discharge of pus into the peritoneal cavity, pleural sac, intestine, and bronchi even, may precede death. The gravity of all cases of pyelitis depends upon the causes and upon the tendency to consecutive suppuration.

Treatment.—This varies according to the cause: the latter needs to be removed, its effects counteracted, and its return avoided. The treatment of calculous pyelitis is essentially the treatment of nephrolithiasis. Primary inflammation of the lower portions of the urinary tract must be combated; causes of retention of decomposed urine, as a urethral stricture or enlarged prostate, must be diminished; infectious fevers must be judiciously handled and irritating diuretics withheld.

Local measures are of value in all forms of pyelitis. Hot-water bags, fomentations, poultices, and dry cupping are often of great service. Internally, the use of diluents is to be recommended, especially the alkaline mineral waters, flaxseed tea, barley-water, skimmed milk and buttermilk, and lemonade.

Hexamethylenamin is the most valuable drug to counteract the infection of the pelvis of the kidney and the associated cystitis, but is of value only when the urine is acid in reaction. Surgical intervention is necessary in severe purulent pyelitis, pyelonephritis, and pyonephrosis.

HYDRONEPHROSIS

Definition.—An obstructive accumulation of urinary fluid in the pelvis and calyces of the kidney; it may cause dilatation, pyelitis, or inflammation and atrophy of the renal structure.

Pathology.—Hydronephrosis is usually unilateral. The pathologic changes consist of a dilatation of the pelvis of the kidney, associated with a degree of atrophy of the renal tissue depending upon the degree and persistence of the pressure. The accumulated fluid causes flattening and atrophy of the papillæ, and gradually of the tubules and glomeruli, as the dilatation and dis-

¹ *Surg., Gyn., and Obst.*, 1916, xxiii, 405.

tention increase, until in extreme cases remnants only of the renal structure remain in the walls of the hydronephrotic cyst. The mucous membrane lining the pelvis and calyces first becomes thinned, and later thickened, by the growth of connective tissue, thus forming the dense sac wall. There is also a growth of connective tissue in the renal parenchyma, medullary and cortical, a chronic nephritis with degeneration and atrophy of the renal cells being set up.

A *nephrydrotic cyst* may be very large, containing as much as several gallons of liquid. Sometimes in medium-sized sacs the external appearance of the walls may be lobulated; the interior, however, usually shows only partial septa projecting from the wall into the cavity of the sac. According to the seat of obstruction one or both ureters may also be dilated. If one kidney is affected, its fellow is often hypertrophied.

The fluid contained in the sac varies in composition, but usually is a clear, thin, yellowish, watery urine. The specific gravity is low, and the reaction is often slightly alkaline. Traces of albumin, urea, uric acid, and salts are found. Turbidity may be present owing to admixture with pus, blood, or epithelium, but only in instances in which previous inflammatory conditions, as a calculous pyelitis, or subsequent complications of like nature have existed.

Etiology.—Hydronephrosis—or, better, *nephrydrosis*—is in most instances secondarily produced by diseases—congenital or acquired—that cause occlusion of the ureter. Probably from 20 to 35 per cent. of cases are congenital (Roberts). In these cases the causal condition is one of stricture due to obstruction caused by a defective development or malformation in the urinary passage of one or both sides, usually the latter. Thus, there may be a valve-like formation or a very acute insertion of the ureter into the kidney. Peacock¹ reports a case with multiple ureters and primary obstruction in the posterior urethra. The dilation has occasionally become so great in the fetus as to cause considerable mechanical difficulty during labor.

Among adults, women are more often subject to hydronephrosis than men, and especially women who have borne children. The condition may be bilateral, as from a stricture low down and due to gonorrheal urethritis, but more often it is unilateral. The causes of these acquired cases are as follows: (1) Impacted calculi in the ureter or renal pelvis. (2) Disease of the ureteral walls, as inflammatory thickening and cicatricial stenosis from ulcers. Geraghty and Frontz aver that the most frequent cause of primary hydronephrosis is an inflammatory contraction of the ureteropelvic junction. (3) Flexion and twisting of the ureter, as from movable kidney. (4) Pressure upon the ureter from without, as by tumors and constricting bands (pelvic adhesions). The gravid and retrodisplaced uterus, uterine and ovarian neoplasms, enlarged and prolapsed spleen, and similar conditions causing compression or traction and obliteration of the lumen of the ureter, are found in this class. (5) Calculus of the lower portion of the ureter. (6) Diseases and tumors of the bladder that involve the ureteral orifices, particularly carcinoma and papilloma, or that cause retention, as prostatic enlargement. (7) Urethral stricture. (8) According to Fenwick, 16 per cent. of all cases are the result of pressure on the ureter by aberrant renal vessels.

Symptoms.—These depend somewhat upon the cause and extent of the hydronephrosis. Marked bilateral disease, when congenital, may render the fetus unviable. The unilateral variety may be overlooked for years, and no symptoms may point to the trouble until a tumor can be made out by inspection and palpation, or until the ureter of the remaining kidney may become obstructed and symptoms of uremia supervene. The latter are more apt to come on, and earlier too, in double hydronephrosis.

¹ *Jour. Amer. Med. Assoc.*, April 8, 1916, p. 1088.

NEW GROWTHS OF THE KIDNEY

The most common tumors of the kidney are those belonging to the class of adenomata (benign) and those that are either sarcomatous or carcinomatous (malignant).

Adenomata may be congenital or acquired. They grow in the cortex of the kidney in the form of small nodular masses, which in some cases may increase to a considerable size before any symptoms are produced. A cystic growth may be combined with adenoma (*cystic adenoma*), and *lymphadenoma* is also occasionally seen as a secondary growth. Other benign tumors that may affect the kidney are *angioma*, *fibroma*, and *lipoma*. Very large vascular adenomata may become malignant. Grawitz, Lubarsch, Kelly, and others have described a variety of tumor (*hypernephroma*) derived from aberrant adrenal tissue misplaced in the kidney. In 32 cases Fraser found morphologic evidence indicating that the tumors were derived from renal adenomata.

Symptoms.—The important points in the diagnosis of hypernephroma are hematuria at long intervals, pain and tumor, the latter giving rise to pressure symptoms. Roentgen-ray plates are of value in differentiating the hematuria of stone (Moffitt).

Sarcoma and carcinoma may be either primary or secondary. *Sarcoma* is frequently congenital in origin, and may have an admixture of striped muscular tissue. The presence of the latter in the kidney points to developmental disturbances during embryonic life as the cause of a variety of tumor known as *rhabdomyoma*. Alveolar sarcoma is also met with. Renal sarcoma is not uncommon in children.

Renal carcinoma is probably of less frequent occurrence than sarcoma; it may, however, be found in children as well as in aged persons, the two extremes of life. Carcinoma of the kidney is usually of the soft medullary or encephaloid variety. As a primary affection it probably originates in the renal tubules. Secondary carcinoma of the kidney, although probably more frequent than the primary form, is seldom of clinical importance. Renal carcinoma may occur as a diffuse infiltration or in nodular masses, one kidney usually being affected in primary carcinoma. The tumor sometimes reaches an enormous size, and instances are recorded in which nearly the whole abdomen has been filled, and in which the growth weighed as much as 31 pounds (14 kgms., Roberts). Rhabdomyomata do not, as a rule, attain a very large size, though sarcomata may grow quite large. Softening and hemorrhage within these malignant growths may occur. The pelvis of the kidney may be invaded, and metastatic areas may form in the liver or the lungs, though this occurs in the case of primary renal carcinoma less readily than from carcinoma in other organs. The renal parenchyma is either partially or wholly destroyed, the pyramids being attacked later than the cortex.

Symptoms.—*Lumbar pain* on the affected side is often an early symptom, and may persist throughout the course of the disease. It may be paroxysmal, and be felt extending down the thigh, or it may be dull, dragging, and limited in character. Pain is not, however, a constant symptom in a certain proportion of the cases.

Hematuria may occur early or late, and often appears before any tumor is palpable. The blood may be in a fluid state or in clots, the latter not seldom taking the form of pelvic or urethral casts, the passage of which may give rise to colicky pains. Casts of the ureter sometimes resemble lumbricoid worms. The hemorrhage may be excessive and cause marked weakness and a symptomatic anemia, superadded to the cancerous anemia that is usually present; on the other hand, it may be so slight as to be discoverable only microscopically.

ful. Renal colic, excessive hematuria, and a gradually lowered vitality may be met by the use of palliatives, tonics, and by nutritious and easily digestible diet.

II. DISEASES OF THE BLADDER

CYSTITIS

Definition.—Inflammation of the mucous membrane of the bladder. It may be either *acute* or *chronic*, the latter being clinically the much more frequent condition.

ACUTE CYSTITIS

Pathology.—Cystoscopic examination performed according to Pawlik's or Kelly's method, hereafter to be described, reveals an intensely hyperemic condition of the vesical mucosa, which is puffy, edematous, and of a bright red color; this may be more intense at points, especially in the vicinity of the trigone. The membrane is bathed in a thick, tenacious mucopus, and here and there may be noted denuded areas, the exfoliated epithelium often hanging in shreds from the bladder wall. Hemorrhagic effusions may be observed. In the severer grades of the disease the intense general hyperemia causes a disappearance of the blood-vessels that are to be seen in the normal condition. Occasionally small patches of ulceration, due to abscess formation (*phlegmonous cystitis*), may be observed, and in rare and fatal instances the entire bladder wall is involved in a necrotic process.

Etiology.—Cases of acute cystitis may be grouped according to their origin into four main classes, as follows:

(1) **Catarrhal.**—Like other mucosæ, the vesical epithelium is very responsive to systemic circulatory disturbances. Thus, sudden exposure to extremes of cold or heat or violent atmospheric changes, thereby abruptly suppressing the action of the skin, may be potent influences in the etiology of the disease. An intense acute catarrhal inflammation may follow retention of the urine in the bladder, with or without its subsequent decomposition; it may also be the result of pressure from an enlarged prostate or other tumor, and may follow cystocele, urethral stricture, or paresis of the bladder wall. In overdistention of the bladder, with the accumulation of a gallon (4 liters) or more of urine, the so-called acute *exfoliative cystitis* may result, in which the entire mucous membrane of the bladder may be shed, and the symptoms of grave uremic intoxication supervene. The prolonged retention of urine is followed by decomposition of the fluid, and this, by its irritant action, always excites a cystitis that soon assumes the chronic type.

(2) **Septic.**—This may result either from the direct introduction of pus-producing germs into the bladder or from the systemic transmission of these micro-organisms to the organ. This is known as the *bacterial origin* of cystitis. Under the first class may be mentioned the passage of an unclean catheter or sound; this is a cause of cystitis in puerperal women, and in men who are the subjects of minor grades of urethral stricture, and who have been subjected to gradual dilatation by means of bougies. *Gonorrheal cystitis* is also to be included under this heading. There is a condition known as *febrile cystitis*, which constitutes the second class of septic cases. This comprises the vesical inflammation that is present in the various febrile conditions, and which is probably a direct result of the presence in the urine of the causal bacilli or their toxins (Fitz). Thus, in all of the infectious diseases and fevers

(typhoid and the other exanthemata, rheumatism, diphtheria, tuberculosis) there is noted a cystitis of varying degrees of severity that can be accounted for only by the local irritant action of the specific germ of the associated disease, or its eliminating toxins. It does not necessarily follow, however, that organisms in the urine will cause a cystitis. The *Bacillus typhosus*, for example, is very generally found in the urine of individuals sick with typhoid, though rarely does a cystitis develop.

(3) **Toxic.**—Certain drugs when introduced into the system manifest an irritant action upon the vesical mucosa, and promptly excite a severe grade of acute cystitis. Prominent among these may be mentioned cantharides and other irritants of the urinary tract—cubebs, copaiba, and sinapis. Workers in coal-tar dye-stuffs are sometimes affected with acute cystitis.

(4) **Traumatic.**—Traumatic inflammation of the bladder follows the improper and careless use of the catheter, sound, or other instrument; the presence in the bladder of calculi or other foreign bodies; and the pressure of the fetus in parturition, or of large masses of impacted feces.

(5) **From Adjacent Inflammation.**—Irritation with consequent inflammation may result from the extension of an inflammatory process from surrounding structures either by continuity or contiguity of tissue. Thus, a cystitis may follow a urethritis—gonorrheal or otherwise; it may result from an extension downward of a ureteritis, or it may be consequent upon a vaginitis, a malignant neoplasm of an adjacent viscus, a salpingitis, pelvic peritonitis, or pelvic abscess in the immediate vicinity of the bladder, as in the vesico-uterine pouch.

The symptoms of acute cystitis are very marked. *Pain, vesical irritability, vesical and rectal tenesmus, frequency of micturition, fever, and urinary changes* are all pronounced. Prominent among these is *pain*, which may be most intense and is the earliest and most persistent manifestation of the disease. Its seat is the suprapubic region, whence it may radiate to the sacral region, the perineum, the end of the penis, or the upper portion of the thighs; it is most constant, but is worst just before micturition, by which it may be alleviated. It is considerably relieved by the recumbent posture, and is aggravated by pressure over the bladder.

With the pain, and probably ranking second in severity, is the *rectal and vesical tenesmus*, or *strangury*. There is an almost constant desire to urinate. The *urine* may be opaque or highly colored. It is often bloody (in very acute cases the vesical contents may consist of a small quantity of pure blood only), is of a specific gravity varying from 1005 to 1030 (in the febrile cases), and contains pus-corpuscles, mucous flakes, shreds of disintegrated and exfoliated epithelium (bladder), and micro-organisms. Thomas R. Brown, in a bacteriologic study of 26 cases, found the exciting causes as follows: *Bacillus coli communis*, 57.7 per cent.; *Staphylococcus pyogenes albus*, 19.2 per cent.; *Staphylococcus pyogenes aureus*, 7.7 per cent.; and *Bacillus pyocyaneus*, *Bacillus typhosus*, and *Bacillus proteus vulgaris* (Haiser), each 3.8 per cent.

Gonorrheal infection may invade the vesical mucosæ when mixed or pure cultures of this organism are recoverable from the urine; fungous mycelial threads and yeast-cells have even been found in certain cases (*mycotic cystitis*). The urine is commonly acid in reaction, though Brown found it alkaline where the excitant was the *Bacillus proteus vulgaris*. It may become less acid or alkaline should the condition become modified. More or less albumin will be noted, and on standing a dense sediment forms in the bottom of the flask, which is composed of all the foregoing substances, as shown by chemical and microscopic examination. The total quantity of urine voided in the twenty-four hours may be normal in amount or even slightly in excess of the normal

On the other hand, if exfoliation of the mucous membrane takes place, there may occur partial or even total suppression of the urine.

Fever, with or without an initial rigor, persists throughout the attack, but is not of a severe type, save in the septic and malignant (diphtheritic) forms of the disease, when it may reach 103° to 105° F. (39.4°–40.5° C.).

Abscesses may form, and betray themselves by localized pain, tenderness, and, in some cases by a circumscribed induration requiring surgical treatment.

In the variety associated with extreme exfoliation of the vesical mucosa *grave uremic manifestations* follow. These include all the features of the typhoid state (dry, brown tongue, mild delirium, nervous and muscular twitching; headache; gastric disturbances; and coma). There is also some degree of malaise and anorexia.

It must not be forgotten that acute cystitis may represent an acute exacerbation in the chronic form, and at times may assume a severe type of the disease.

Diagnosis.—Cystitis should be readily recognized from the history of the case and the frequency of the two almost pathognomonic symptoms—suprapubic pain and vesical tenesmus. An examination of the urine will reveal the characteristic clinical features. The percentage of albumin is usually much larger in nephritis than in irritability of the bladder. The differentiation between cystitis and vesical irritability will be noted under the latter condition. Urethritis may be excluded by means of the two-glass test. For example, if urination into two glasses reveals pus in both, after carefully washing out the urethra as far as the compressor urethræ muscle, it is “very positive proof that cystitis or some inflammation further up the canal is present” (Greene and Brooks).

The **prognosis** of the milder grades of cystitis is good; the septic and malignant cases offer a much graver outlook. Extension of the process upward toward the kidneys is always serious.

The **treatment** of acute cystitis includes prophylactic, hygienic, and medicinal measures.

Prophylactic.—Most important is the prevention of the disease, and this includes, in addition to the usual care of the body, the observance of thorough asepsis during catheterization.

Hygienic.—The cause of the disease, if evident (calculus, external pressure), should be sought and removed. The patient should at once be placed absolutely at rest in the recumbent posture. The *diet* must be regulated, and all irritating, highly seasoned articles of food must be interdicted. Alcohol in any form is prohibited. An absolute milk diet will be most beneficial. The patient should be instructed to drink freely of water and other diluent drinks. The free action of the skin may be secured by friction and warm bathing.

Medicinal.—The drugs to be employed are the saline laxatives and the various mild diuretics and urinary antiseptics. The reaction of the urine will indicate the variety of antiseptic to be employed. If it be acid, hexamethylenamin is the drug that is indicated. It may be given in doses up to 60 grains (4.0) a day. In alkaline conditions of the urine probably the most valuable drugs are benzoic and boric acids and salol. Benzoic acid is best administered in the form of ammonium benzoate, which may be given in 10-grain (0.6) doses thrice daily. If possible it is best to acidify the urine by giving acid sodium phosphate or some such drug and then give hexamethylenamin. Hot applications and hot local bathing (sitz-baths) will do much to relieve the pain and tenesmus; if these be severe, a rectal suppository of opium and belladonna or an enema of chloral hydrate will generally give prompt relief. Tincture of cannabis indica, administered internally, may answer if opium be contraindicated. Under such a course as the preceding a

slowly, and not more than twice or thrice daily in severe cases, and much less frequently in ordinary cases, according to the exigencies of the condition.

Vesical medication may be secured by means of the funnel after irrigation, the medicating substances being dissolved in a pint of water and allowed to flow slowly in and out of the bladder. The drugs that may be used in this manner are silver nitrate or zinc sulphate (1–5 gr. to the ounce—0.065–0.3 to 30.0) or a saturated solution of boric acid. If the salts of zinc or silver are used, not more than an ounce of the solution should be allowed to enter the bladder, and much less than this amount will generally suffice. In cases in which there exist patches of ulceration the application must be made directly to these areas through the endoscope or cystoscope. Stronger solutions may now be employed, as silver nitrate, 20 to 30 gr. (1.3–2.0) to the ounce. This application should be followed by a slight irrigation of the bladder.

When this local medication fails to effect a cure, permanent drainage of the bladder must be secured—in the male by a suprapubic or perineal incision, and in the female by the establishment of a vesicovaginal fistula. This places the bladder absolutely at rest, and gives the inflamed mucosa a chance to heal under proper medication.

As to internal remedies, various agents that possess a local stimulating effect upon the genito-urinary tract are advised by most authors, but I think little is to be gained from their employment as compared with the results achievable from topical treatment. Most efficacious among internal remedies are oil of sandalwood, terebene, hexamethylenamin if the urine be acid.

NEOPLASMS OF THE BLADDER

Primary new growths of the bladder are exceedingly rare, occurring, however, with greater frequency in males in about the proportion of 3 to 1; they may be either benign or malignant. On the other hand, secondary neoplasms, particularly carcinomas, are relatively common. The most frequent variety of new growth encountered is carcinoma, particularly the so-called villous or papillomatous carcinoma, Williams finding in 20 women affected with bladder tumor, carcinoma in 16. Other growths are sarcomatous, fibromatous, cystic, and papillomatous in nature.

The **symptoms** are the same for all varieties, and include, first and most commonly, *hemorrhage* (which is both persistent and free), together with pain, frequency of micturition, and occasionally the discharge of detached fragments of the growth. In carcinomatous cases of advanced standing cachexia will be marked. By means of the cystoscope the nature of the complaint is disclosed. In the case of secondary growths the primary tumor may often be detected.

The **prognosis**, of course, will depend upon the nature of the growth.

The **treatment** is purely surgical.

VESICAL HEMORRHAGE

Hemorrhage of the bladder has been mentioned as a symptom of various affections, both general and local, among the former being leukemia and malarial hematuria, and among the latter nephrolithiasis and tuberculosis and carcinoma of the bladder. It is also a prominent manifestation in stone in the bladder, and not infrequently appears in pregnancy (late). Independently of the opera-

tion of all of the above-mentioned etiologic factors, hemorrhage has been known to occur from the bladder, and recent precise methods of exploring the viscus (endoscopic examination) have shown it to be due to a hemorrhoidal state of the vessels or to ulceration. The hemorrhage may be profuse, and, rarely, even fatal in its effects.

The **diagnosis** is based in part upon the absence of the more obvious causes of hematuria and the presence of free bleedings, but chiefly upon the result of a careful cystoscopic exploration of the bladder.

The **prognosis**, so far as my experience extends, is eminently favorable, though a few fatal cases have been reported.

Treatment.—This is mainly local. The bladder may be irrigated with an astringent solution (1 per cent. tannic acid, $\frac{1}{2}$ per cent. alum), and this may be alternated with an antiseptic solution (3 per cent. boric acid, 1 per cent. salicylic acid).

NEUROSES OF THE BLADDER

IRRITABILITY OF THE BLADDER

Definition.—By this term is meant a condition of the bladder in which there exists a hyperesthesia of the organ, especially of the neck—that portion surrounding the urethral and ureteral orifices (*vesical trigone*)—without the presence of any tangible cause therefor. This must be distinguished from the irritability that is associated with true organic disease of the bladder itself, as in the presence of calculi, tumors, or fissure of the neck, or with disease of the surrounding structures.

Pathology.—Cystoscopic examination of the bladder may reveal a slight increase in the vascularity of the mucous membrane. The condition of irritable bladder in women, which has previously been held to be a purely functional derangement, is now regarded by Dacheux and Zuckerkandl as a localized hyperemia, especially at the *bas fond*, and less often at the beginning of the urethra.

Etiology.—While in many instances no well-defined causal relations can be determined, it is very generally true that the patients who are the subjects of vesical irritability are individuals of a neurotic temperament, very often manifesting strong hysteric tendencies. They are generally ill-nourished, fretful, irritable, peevish, suffering almost constantly from vague neuralgic attacks in different portions of the body (cephalgia, tic douloureux, lumbosacral pain), and in a chronic condition of physical prostration. Frequently they eventually develop a true hypochondriasis or melancholia. In others there may be found a history of extreme mental and physical tire, overwork, business anxiety, overindulgence in venery, menstrual irregularity, dysmenorrhea, ovarian or uterine disorders, long-continued gastro-intestinal disturbance (dyspepsia), improper hygienic surroundings, improper regimen, indulgence in late hours, and a general lack of will-power. It must, however, be remembered that subjects of chronic malarial intoxication very often manifest all the symptoms of vesical irritability, marked, it may be, by a feature of more or less periodicity. The condition must commonly, however, be regarded as belonging essentially to the large group of neuroses.

In a certain percentage of cases the bladder trouble is a reflex manifestation of some disease of an adjacent organ, as the urethra, ureter, vagina, rectum, anus, or the internal organs of generation. These are not, however, to be looked upon as cases of true neurotic vesical irritability.

able bladder are mainly extreme painfulness and associated with marked *vesical* and *rectal tenesmus*. It is usually relieved by micturition; indeed, the pain is often more severe, or even worse after, than before, the voiding of the urine. This is true when there coexists a more or less spasmodic contraction of the bladder walls, the hypersensitive mucosa then being the patient suffering at times to such an extent as to be thrown into a state of collapse. There is usually a sense of weight or pressure in the pelvic region, which is largely relieved when the patient assumes the recumbent posture. Urination is often performed spasmodically, or there is a spasm of the urethra and neck of the bladder resulting in an utter inability to perform the act. The *urine* may be normal in appearance and very often it is increased in quantity (*hysteric polyuria*), and at the same time the opposite may be true and more or less suppression be noted.

Diagnosis.—Very frequently will simple vesical irritability be confounded with cystitis. The points of differentiation, however, are as follows:

IRRITABLE BLADDER

Is of a neurotic temperament; generally gives no history of bladder disease nor of operation on the bladder.

Pain is usually worse after micturition.

Constitutional symptoms are those of depression.

May result fatally.

Does not present any marked changes in its physical or chemical qualities. It may show hyperacidity, hyperconcentration, or dilution.

Reaction of the mucosa is negative to cystoscopy.

Course is always protracted.

CYSTITIS

May occur in any individual, irrespective of temperament. It frequently follows catheterization, sounding, or other traumatism.

The pain is usually much relieved by micturition.

The constitutional symptoms are not marked, save in grave cases.

May result fatally.

There are always present marked and characteristic alterations in the physical and chemical qualities of the urine.

Cystoscopic exploration reveals the angry and diseased mucosa, and may show the cause (calculus, tumor).

The duration of acute attacks may be short.

Prognosis.—Good as regards life; doubtful as regards the ultimate cure of the condition.

Treatment.—Since the condition is largely one of neurotic origin, the physician must be directed mainly toward a betterment of the nervous system. Absolute rest, physical and mental, must be enjoined, and the patient must be subjected to a course of strict moral discipline, never this may be deemed necessary. Any cause of reflex irritation must be removed, and a careful search should be instituted for some local lesion, such as cervical stenosis, uterine displacements, anal fissure, hemorrhoids of the rectum, vaginitis, urethritis, tuberculous infection of the bladder, or of the urethra, chronic gastro-intestinal catarrh, and the like. The diet of the patient must be inquired into, and late hours, the eating of indigestible and unwholesome articles of food, masturbation, or the reading of trashy literature corrected. In many instances the pronounced condition demands a course, more or less protracted, of the Weir treatment (*vide* Neurasthenia, p. 1187). The urine should be examined for pathologic features, and by an appropriate course of treatment should be rendered as bland and unirritating as possible. Large quantities of diluent drinks may be of benefit, and if these be combined with the administration of nerve sedatives and antispasmodics, a marked improvement of the patient's condition may be secured. In cases associated

with spasmodic muscular contraction it may become necessary to employ an occasional suppository of opium and belladonna, or an enema of chloral hydrate. Change of air and scene, regulation of the diet, the institution of a proper course of gymnastics, mental and physical, and the observance of a happy and cheerful atmosphere will generally do much to improve the patient's condition. The administration of tonics (strychnin, iron) and the prevention of constipation are very essential. Especially must it be remembered that in all these cases of simple vesical irritability physical exploration of the bladder is absolutely contraindicated. The patient's mind must be directed away from the bladder in order to secure good results.

NEUROSES OF MICTURITION

1. **Incontinence of Urine (*Enuresis*).**—An inability to retain the urine. This may arise from a number of causes. Frequently it is the result of some lesion of the spinal cord involving the sphincteric center of the bladder; this is known as *paralytic incontinence*, and is to be recognized by a constant dribbling, alternating with spurts of urine when voluntary or involuntary muscular action is brought into play, as in the act of coughing, sneezing, or bending forward of the body. It may be the result of a general bodily weakness or after prostrating diseases (typhoid, late stages of pulmonary tuberculosis). Again, it may result from some local condition in the bladder or urethra. Here may be mentioned paralysis of the urethra from overdilatation or from traumatism, or that due to pressure of the fetal head in a prolonged labor; imperfect vesical innervation; overdistention of the bladder, producing a paresis of its walls; or from some temporary obstruction at the urethra or base of the bladder, such as a tumor or a sharply retroflexed uterus. It may be a result of overdistention of the bladder, with partial paralysis of the sphincter, the bladder remaining overfilled, while there is a constant escape of a few drops of urine (*incontinence of retention*). It may follow some local causes of irritation, as the presence of vesical calculi, pressure from an anteflexed uterus upon the fundus of the bladder, cystitis, and parasites. The condition known as *spasmodic incontinence* is that due to an overaction of the compressor muscle of the bladder, as a consequence of which there is a diminution of the vesical capacity, the urine being forcibly and involuntarily ejected at irregular intervals. Finally, *nocturnal enuresis* is that variety which is so common in young, delicate, and often neurotic children: this is usually noticed in the early hours of sleep, and is often the result of some local irritation acting upon a hypersensitive organism, such as the presence of oxyurias, an elongated prepuce, contraction of the urethral meatus, or masturbation. Bierhoff is of the opinion that the essential or ultimate condition is hyperesthesia of the deep urethra or sphincter from hyperemia or inflammation. Pelzman found on cystoscopic examination trabeculation of the bladder varying in degree from a mild to a marked type. Nocturnal incontinence may be a manifestation of nocturnal epilepsy or of incipient cerebral or spinal disease (Fitz). Adenoid vegetations may bear an indirect causative relation to the condition, and it may be a symptom of thyroid hypoplasia. In the female, urethral papillomata and caruncles have been assigned as causes. The hyperacidity of the urine associated with podagra may also excite enuresis. The constant escape of urine in the paretic cases is apt to result in extensive excoriation of the parts.

The *treatment* varies according to the cause. The enuresis of children, if left alone, will eventually cure itself as the age and strength of the patient increases, though obvious exciting causes, if present, should be removed if not impracticable. Good hygiene, systematic evacuation of the bladder, elevation of the hips on a pillow in bed, plenty of out-of-door exercise, a change

to the seashore or mountains, an abundance of suitable and strengthening food, mainly vegetable, so that a large proportion of the fluid output occurs by way of the intestines, with a minimum of water, and milk, especially late in the day, and the administration of tonics (iron, cod-liver or olive oil, and strychnin), will generally effect a cure. The fluidextract of *rhus aromatica* in 5 to 15 drop doses, thrice daily, has been very beneficial in children. Excellent results often follow the administration of minute doses of atropin or tincture of belladonna.

In very delicate or feeble children suffering from enuresis I give a motor tonic and stimulant (tr. nucis vom.). In cases showing marked hyperacidity the alkalies or alkaline mineral waters, with careful rearrangement of the diet, are indicated. Klotz advises to raise the foot of the bed and make the patient sleep on his side. Again, the little sufferer may be awakened prior to the hour for the occurrence of the incontinence.

Spasmodic action of the vesical compressor may be relieved by the cautious use of the motor depressants, while its converse, paresis, demands the exhibition of full doses of strychnin or tincture of nux vomica. The judicious and careful use of the catheter, followed by the administration of strychnin, will promptly effect a cure in the incontinence of retention not caused by an organic obstruction such as an enlarged prostate. Any local cause of vesical irritation must be removed. Galvanism in the parietic cases, applied both to the bladder and to the urethra, may be of service. Forchheimer uses the faradic current; in girls one pole is introduced into the vagina, in boys into the rectum, while the other pole is placed over the region of the bladder. The current must not be of too great strength, and he begins with the weakest induction current, which is gradually increased. In the female Snger suggests massage of the urethra. Vibratory massage has proved successful in a few cases. Should excoriation occur, bland ointments, as of zinc oxid and lanolin, should be used. Removal of adenoid vegetations has been recommended in cases in which they produce conditions of malnutrition. For cases caused by thyroid insufficiency, the use of thyroid extract will relieve the enuresis and also bring about marked improvement in the general physical and mental condition. Mikhailoff¹ reports prompt benefit following treatment with pituitary extract.

2. Retention.—Nervous retention of the urine is occasionally encountered in hysteric and highly neurotic individuals. Its most common manifestation is an inability to urinate in the presence of others. It is also occasionally noted after childbirth, when it may be due to nervous reaction, to edema and tortuosity of the urethra, or to a temporary inability of the bladder walls to contract upon their contents, thereby permitting a longer retention of the vesical contents, and even favoring overdilatation of the organ. If the urine be allowed to remain for too long a period in the bladder, fermentative changes follow and a secondary cystitis will result. Under these circumstances an exfoliation of a portion or even of the entire bladder epithelium may be noted.

The *treatment* consists in the administration of strychnin and other nerve tonics, in building up the general constitution, and in affording a change of air and recreation. In that variety following childbirth the patient should be urged to make voluntary efforts at micturition, and these may be seconded by the firm application of an abdominal binder and compress, or of hot, moist flannel cloths, kept up for twenty minutes or a half-hour. The sound of running water, as when pouring water from a pitcher into the basin, often causes a contraction of the bladder and excites the flow of urine. It may become necessary, the foregoing methods failing, to resort to catheterization, the usual antiseptic precautions being observed.

¹ *Russkiy Vrach.*, June 17, 1917, p. 370.

PART X

DISEASES OF THE NERVOUS SYSTEM

THE central nervous system is generally divided into two parts—the brain and the cord. The *brain* consists of the cerebral hemispheres, the basal ganglia, the cerebellum, the pons, and the medulla. The cerebral hemispheres are joined together by the corpus callosum and the anterior and posterior commissures. They are united to the pons by the crura cerebri, and the pons is continuous with the medulla, which in turn is continuous with the spinal cord. The surface of the cerebral hemispheres is divided by sulci or fissures into various regions, known as the frontal, parietal, temporosphenoidal, and occipital lobes. The superior longitudinal fissure separates the two hemispheres; the fissure of Sylvius is between the frontal and parietal lobes above and the temporosphenoidal lobe below. The fissure of Rolando divides the frontal from the parietal lobe, and the parieto-occipital fissure the latter from the occipital lobe. The continuation of the last-named fissure upon the median surface forms the upper boundary of the cuneus, the lower boundary of which is the calcarine fissure. The hippocampal fissure separates the fascia dentata from the hippocampal gyrus, and by its extension inward produces an elevation in the lateral ventricle known as the hippocampus major. Each lobe is subdivided by secondary fissures into a number of lobules. The topography of the hemispheres is important because it is now possible to map out with considerable accuracy the regions in which various motor impulses originate, and with less accuracy the regions in which various sensory phenomena are perceived.

The central nervous system is composed practically of two elements—the neuroglia, or supporting substance, and the neurons. The neuron is the active part, and consists of a cell body containing a nucleus which, in turn, contains a nucleolus; a number of processes arising from the cell body which are similar in structure to it—*i. e.*, protoplasm—and known as dendrites or dendrons; and a process of different structure which arises either from the cell body or a dendrite, known as the axon or axis-cylinder process. Each neuron is an independent nerve unit and probably has no anatomic connection with any other neuron. The axis-cylinders, however, arising from certain cells may divide into a brush-like tuft of fine fibers which surrounds the cell bodies and dendrites of other neurons. In this way there is a physiologic connection, and such combinations form the various motor and sensory tracts. Axis-cylinders which arise from the cells in the gray matter of the pons, medulla, and anterior horns of the spinal cord end in the so-called motorial end-plates in the muscles. The function of a cell body may be to either originate motor impulses, to control muscle tone, to modify impulses received from another neuron, to act as reflex centers, exercise a trophic or nutritive influence on muscles, bones, skin, etc., or to receive and recognize sensory impressions. Certain cells may combine several of these functions, thus, the cells in the anterior horns of the spinal cord receive motor impulses from the cortical

The most important tracts are the motor and sensory. The first consists of two neurons, the *upper* or *central* and the *lower* or *peripheral*. The cell bodies of the former are in the ascending frontal or precentral convolution (p. 1017); from these the axons converge to the internal capsule, where they occupy the posterior limb. They pass from here through the crus, pons, and medulla, in the lower part of which most of them decussate and cross to the opposite side, passing down the cord in the posterior portion of the lateral column of the spinal cord (crossed pyramidal tracts) (Fig. 63). The small portion which do not decussate pass down in the anterior columns (direct pyramidal tracts) (Fig. 63). The terminals of these fibers surround the cells either in pons and medulla, which constitute the nuclei of the cranial motor nerves or those in

Fig. 63.—Diagram of the direct or voluntary motor tract, showing the center of the motor impulses from the cerebral cortex of the voluntary muscles (Van Gehuchten). *m*, Muscles; *n*, cells of nuclei of motor cranial nerves in pons and medulla; *a*, motor cells in anterior horns of spinal cord; *dpt*, direct pyramidal tract; *cpt*, crossed pyramidal tract; *pc*, peripheral cranial nerve; *ps*, peripheral spinal nerve.

the anterior horns of the spinal cord. These cells are the beginning of the peripheral neuron and their axons form the motor cranial and the motor portion of the spinal peripheral nerves (Fig. 63).

In connection with the motor tracts the *extrapyramidal tracts* are of importance; their exact course is not definitely known. According to Mills, they probably begin in the cortex anterior to the motor area (midfrontal region). From here the axis-cylinders go to the corpus striatum, especially the lenticular nucleus (p. 1021), and then to the red nucleus and cerebellum. He believes that from here afferent fibers pass to the parietal lobe, and from there to the motor cortex. Afferent fibers also pass from the cerebellum to the red nucleus. Mills has called this the "tonectic apparatus." The functions of the central

neuron or the pyramidal tract are as follows: The cells originate motor impulses which pass through the axis-cylinders to the cells in the anterior horns of the gray matter of the cord. It also probably conveys impulses received from the extrapyramidal center and tract that control muscle tone (*infra*). The cells of the peripheral neuron receive the motor impulses from the central neuron and send them to the muscles through the peripheral motor nerves (cranial and spinal). They also control the nutrition of the muscles (trophic centers) and act as reflex centers, that is, they act as the center of a reflex arc, receiving sensory impulses from the sensory nerves and sending out motor impulses through the motor nerves (p. 1027).

The extrapyramidal tracts are thought to influence muscle tone and possibly control it. Lesions in its course cause increased tone, as shown by spasticity and tremor (p. 1021). Lesions which partly destroy the pyramidal tract, owing to the fact that tonic innervation will be irregular and aberrant in its manifestation, also cause spasticity or hypertonicity, and usually increase of the tendon or deep reflexes, as these depend upon muscle tone for their presence. If, however, the pyramidal tract is completely destroyed, as when the spinal cord is divided. For several weeks there is hypotonicity and flaccidity of the muscles with loss of the tendon jerks, followed by return of the reflexes. Eventually, however, they are permanently lost.

Owing to these facts certain symptoms are characteristic of a destructive lesion partly destroying the upper motor neuron or pyramidal tract, and of a lesion interfering with the functions of the peripheral neuron. They are shown in the following table:

TABLE SHOWING SYMPTOMS DUE TO CENTRAL NEURON DESTRUCTIVE LESION AND THOSE DUE TO PERIPHERAL NEURON LESION

	<i>Lesion of upper neuron.</i>	<i>Lesion of peripheral neuron.</i>
Muscle tone.	Increased more or less. Complete destruction causes flaccidity at first.	Diminished or lost. Flaccid paralysis.
Reflexes.	Tendon jerks or deep reflexes usually increased. Babinski reflex present.	Diminished or lost (both tendon and skin (p. 1028). Babinski reflex absent.
Nutrition of muscles.	Good. Sometimes slight atrophy from disuse, and if the lesion occurred in childhood, lack of growth of the entire limb.	Muscles more or less wasted.
Electric reactions.	Same as the normal muscle.	Changed. Either a diminished response or the reaction of degeneration.

The *sensory tracts* comprise several different pathways conducting different forms of sensation. The cells of the first neuron are situated in either the posterior root ganglia or those of the sensory cranial nerves, as the case may be. From each cell there arises a long dendrite which goes to the periphery and ends as an end-organ in either the skin, mucous membranes, muscles, or joints. If a spinal nerve, the axis-cylinder enters the spinal cord, where it divides into a long ascending and a short descending branch. Many of the former go to form the *posterior columns* (Goll and Burdach) (Fig. 64) and end in the nucleus gracilis and nucleus cuneatus respectively. The cells of these nuclei are the beginning of another neuron the axis-cylinders of which form the lemniscus or fillet. Here the fibers decussate and pass to the optic thalamus of the opposite side, in the cells of which another neuron begins, whose axis-cylinders pass through the posterior part of the posterior limb of the internal capsule (Fig. 71), and hence to the parietal region of the cortex. In a

this must be remembered in testing for absence of tactile sensibility, and substances used that make the least pressure possible.

To summarize: Sensations of *touch* are conducted in the posterior columns and others not definitely known. Some pass up on the same side of the cord until they reach the pons, when they cross to the other side; others possibly cross to the other side in the cord. Sensations of *pain, heat, and cold* are conducted by the tractus spinothalamicus and spinotectalis and possibly by Gower's tract. They pass to the other side shortly after entering the cord. *Muscle sensations* are conducted by the posterior columns and direct cerebellar tracts, the fibers of which do not decussate.

Fig. 65.—Indirect sensory tracts (Van Gehuchten): dot, Direct cerebellar tract. The numbers represent the different series of neurons.

The so-called *vegetative nervous system* is of great importance. It is a system of efferent fibers which supply those organs whose action is not under control of the will, i. e., those containing involuntary and smooth muscle-fibers, as the viscera, blood-vessels, musculature of the skin and iris; certain organs containing striated muscle, as the heart, esophagus, genito-urinary, and the various glands. It is composed of the *sympathetic nervous system* and some cranial nerves—viz., pneumogastric, oculomotor, chorda tympani; and some spinal nerves arising from the lower sacral segments, which are known as the *autonomic system* (Fig. 66). As the sympathetic system is in close relation with the spinal nerves and cord, it can readily be seen that diseases affecting these parts may cause various vasomotor and secretory symptoms.

In addition to the knowledge of the course and functions of the tracts

just described, which enables us to determine the location of lesions in the cord (p. 1027), the function and location of many centers are known, a know-

CONCRETE CONCEPT

Fig. 67.—Side view of human brain, showing localization of functions (Charles E. Mills).

ledge of which often enables us by a study of the symptoms to determine which part of the brain is affected (Figs. 67, 68).

CEREBRAL LOCALIZATION

In applying this knowledge it must be borne in mind that symptoms may be due either to irritation or destruction of these parts (p. 1034), and that similar symptoms referable to neighboring centers and tracts may be due to pressure upon them by the lesion. This is especially the case with tumors. Such lesions, also, if they cause much increase in the size of the brain may distort it so that nerves are pulled upon or pressure made on parts some distance from the lesion. This is especially the case with the sixth nerve.

Frontal Lobes.—That part of the frontal lobe just in front of the motor region (prefrontal region) (Fig. 67) is the seat of the higher mental functions, as memory, judgment, reasoning, attention, etc. Many believe that in right-handed people the left lobe is the active one, and *vice versa*. In front of this area (midfrontal region) Mills has placed his center for muscle-tone. Lesions in this area cause a symptom known as either *tonic perseveration* or *tonic innervation*. It is manifested by inability to immediately let go of an object after it is grasped, in other words, to relax innervation in a muscle group or groups. The symptom occurs on the side opposite the lesion. It is usually associated with some degree of motor paralysis and must not be confounded with either myotonia (p. 1210), clonic perseveration, or intentional perseveration (p. 1026). Lesions in this region on the left side have caused apraxia (p. 1026). In the third frontal on the left side is situated the center for motor speech, memories, and probably in the second frontal that for the muscular movements essential for writing (see Aphasia).

Motor Region.—The centers which originate voluntary motor impulses are in the entire ascending frontal or precentral convolution (Figs. 67, 69), partly

but it has been shown that muscles which habitually act together, as those of respiration, swallowing, speech, closing the eyes, and facial expression, may be innervated from either side of the brain, and if one side is disabled the other side will take up the work. Muscles which control the functions mentioned, therefore, sooner or later regain their power. If, however, the association fibers are cut off or a similar lesion occurs on the other side, function does not return (pseudobulbar palsy, p. 1088).

Postcentral Convolution.—In this, also known as the ascending parietal convolution, are probably located the centers for *cutaneous sensation* (Fig. 67).

Parietal Lobes.—In the upper part is situated the center for the *stereognostic sense*. By this is meant the ability to recognize an object, without seeing it, by its peculiar shape, weight, hardness, etc. (see p. 1026).

In the lower part is an area for memories of *muscular movements*. A lesion here causes irregularity of such movements, (ataxia) and loss of the sense of position. The former is indicated by inability to make fine movements, such

Fig. 69.—The subdivisions of the motor cortex (Mills and Frasier).

as touching the end of the nose with the finger (finger-to-nose test), the eyes being closed, or to place the heel on the opposite knee (heel-to-knee test), smoothly and regularly. When attempted coarse irregular tremors result (see *Asynergy*, p. 1022). By the latter is meant inability to recognize the position of all or part of a limb with the eyes closed. On the left side is located the center for memories of written and printed words (see *Aphasia*). Lesions on the left side have also caused *apraxia* (p. 1026).

Occipital Lobes.—These are important as the secondary visual centers, which are located in the cuneus, about the calcarine fissure (Figs. 67, 68).

Irritative lesions may cause visual hallucinations, as flashes of light. Such phenomena may also occur in migraine (p. 1161), but if due to an organic lesion, such as a tumor, impairment of function will sooner or later occur, which is manifested by lateral homonymous hemianopsia (p. 1051).

Temporal Lobes.—Destruction of one lobe causes some slight impairment of hearing in the opposite ear. In the first temporal convolution of the left side

Crus Cerebri.—As the third cranial nerve passes through the crus near the pyramidal tract, a symptom group characteristic of a lesion here is hemiplegia of the side opposite the lesion and a third nerve palsy (p. 1054) on the same side (syndrome of Weber). Hemianesthesia will occur if the tegmentum is involved, and interference with the functions of the red nucleus causes either tremor or athetoid movements (p. 1124). As the optic tract crosses the crus it may also suffer, and if so, lateral homonymous hemianopsia will occur (p. 1051).

Corpus Striatum.—This is part of the extrapyramidal tract system (p. 1012), and evidently exercises a controlling or inhibitory influence upon muscle tone. Lesions of the *lenticular nucleus* cause spasticity and tremor without motor paralysis and the Babinski reflex (pp. 1125, 1132). Causeless emotionalism may also occur, and Mills believes that if the emotions are painful there is a lesion of the *caudate nucleus*. Other symptoms which may be present are due to disorder of the vasomotor and secretory systems, which causes disturbances of pulse, respiration, temperature, and glandular activities. (See also Marie's *Theory of Aphasia*, p. 1026.)

Optic Thalamus.—This is part of the sensory tract (p. 1013) and is also connected with special sense paths. Together with the anterior corpora quadri-

Fig. 71.—Diagram of horizontal section through the basal ganglia and internal capsule (left side), showing the position of the chief tracts in the internal capsule. The region of the capsule marked by the letters *L A F* is occupied by motor fibers: *L* corresponds to the leg fibers, *A* to the arm fibers, *F* to the face fibers (including fibers to face muscles and tongue). The region *F-C* contains the frontocerebellar tract (intellectual tract). The region marked *S* contains the general sensory tract from the opposite side and the fibers from the optic and olfactory nerves of the opposite side, sometimes called the "sensory crossway." (Potts, "Nervous and Mental Diseases.")

gemina and external geniculate bodies, the pulvinar forms part of the primary optic centers (p. 1051). Pure thalamic lesions have caused hemianesthesia, pains, hemiataxia, and choreiform movements involving the affected side, paralysis of the facial muscles when used to express the emotions, with preservation of voluntary motion, causeless laughter, and crying. Hemianopsia of the lateral homonymous type may be present (p. 1051).

Corpora Quadrigemina.—The anterior tubercles form part of the primary optic centers (p. 1051). The posterior tubercles with the internal geniculate bodies are connected with the auditory nerves and cerebellum. Lesions of this part cause diminution of hearing and inco-ordination of the cerebellar type and loss of associated upward movement of the eyes (see p. 1132).

Pons.—The most prominent symptom indicating a lesion here is *crossed or alternating paralysis*. By this is meant weakness of the arm and leg on the side opposite the lesion, with paralysis of cranial nerves on the same side (Fig. 70). The cranial nerves which may be so affected are the facial, the paralysis being of the peripheral type (p. 1060), sixth, eighth, and fifth, both motor and sensory divisions. When either the sixth nucleus, its vicinity, or the posterior longitudinal bundle is involved there is loss of lateral conjugate movement of the eyes to the side of the lesion (p. 1055). This distinguishes sixth nerve palsy due to this

cause from involvement of the sixth nerve trunk at the base of the brain. In the latter case the palsy will be limited to the sixth nerve of the affected side, and loss of lateral associated movement will not occur. If the sensory tracts are involved, hemianesthesia occurs. If the lesion is below the upper third, this is crossed. When the middle cerebellar peduncles are involved, inco-ordination of the cerebellar type occurs. Hyperpyrexia may occur in acute lesions.

Medulla.—This contains the nuclei of the ninth, tenth, eleventh and twelfth cranial nerves, and motor sensory tracts. A lesion here causes bulbar symptoms (p. 1087), which develop either suddenly or gradually as the disease is acute or chronic. There may be weakness of the arm and leg, which may be on either the same or opposite side, depending whether it is above or below the decussation of the pyramids. Pressure on the fourth ventricle may cause polyuria and glycosuria.

Cerebellum.—The principal function of this part of the brain is the controlling of *synergy* or *synergia*. By this is meant “the power or faculty by which movements, more or less complex, but functionally definite, are associated in a special act or acts. It is motor association being carried out in movements of different parts of the same limb or in synchronous movements of the limbs and trunk” (Mills and Weisenburg). Every co-ordinate movement of the body and limbs is dependent upon the synchronous action of a number of muscles, the contraction of which must be accurately timed. If this is not so, the movement is performed in an irregular or inco-ordinate manner, which is termed *asynergy* or *asynergia*. For this purpose sensations travel to the cerebellum from the muscles, joints, tendons, and possibly to some extent from the skin by way of the peripheral nerves, posterior columns, and direct cerebellar tracts (p. 1015).

Lesions in these parts will also cause inco-ordination, but of a different type (pp. 1044, 1151).

It is believed that the upper part of the vermis controls movements of the shoulder-girdle and upper part of the trunk, and the lower part controls those of the pelvic girdle and lower part of the trunk.

Base of the Brain.—Lesions here cause different symptoms according to their location and the structures pressed upon or involved. More or less paralysis of cranial nerves occurs, the pituitary body may be involved, or the crura or cerebellum suffer from pressure. (See section on Cranial Nerves and pp. 1132, 1133.)

Centers Controlling Speech and Allied Functions.—Those controlling written and spoken speech are the third frontal, possibly the second frontal, the first and second temporal, and the angular gyrus, all of the left side in right-handed people. Interference with the function of any or all of these centers causes what is known as aphasia. Disturbance of allied functions and the centers controlling them will also be discussed during its description.

APHASIA

Definition.—By aphasia is meant either a partial or complete loss of the power of either expression or comprehension (or of both combined) of any of the usual signs of language, not dependent upon lesions of the peripheral nerves or organs, but upon lesions of the cortical centers concerned in speech, or the tracts connecting them.

Etiology.—Aphasia, in most cases, and practically always, if permanent, is due to a destructive lesion of either the centers or tracts above mentioned.

Usually this is either caused by a cerebral hemorrhage or acute softening (*vide* apoplexy), and is, therefore, frequently associated with hemiplegia. It may, however, be caused by any organic lesion, as tumor, encephalitis, or abscess. Transient aphasia may be caused by so-called functional disturbances. It may follow severe fright, anger, hemorrhage, and exhaustion; occur as a symptom of migraine, or be caused by toxemias, as uremia, gout, vegetable and mineral poisons, and infectious diseases.

The Genesis of Speech and Location of Centers.—To properly understand the development of the symptoms of aphasia, some knowledge of the evolution of language is essential. The child learns to understand language before he can utter it. Through the different senses he perceives the different characteristics and appearance of an object. These percepts are stored away in the brain, and gradually the child learns to associate the name that he hears applied to a certain object with that object. The memory of the sound of this word is stored in the center for word memories, which is in the first temporal convolution of the left side in right-handed persons, and *vice versa* in those who are left handed. Whenever this word is used, the various characteristics of the object are at once brought into consciousness by a stimulation of the different centers where the memories of these characteristics are stored. Eventually the child learns to make the various co-ordinated muscular movements necessary to pronounce the word. The memory of necessary movements of the lips (tongue, larynx) required to pronounce a word are also stored in a center, which in right-handed persons is the foot of the third left frontal convolution (Broca's convolution, psychomotor center, glossokinesthetic center of Bastian). The exciting of one of these centers excites the others; thus, if we hear the ringing of a bell, a mental image of the other characteristics of the bell is formed, and the proper word designating that image comes into consciousness by stimulation of the center for word memories. If it is desired to pronounce the word, an impulse is sent from this center to Broca's convolution, which starts in motion the various movements of the organs of speech necessary to pronounce the word.

Even if a word is not audibly pronounced, mental images of words enter into thought processes, as do also the muscular movements necessary to pronounce the word. This is constantly being done in silent thinking, when the sounds of words are mentally recalled without visible movements of the muscles necessary to pronounce the word being made. This has been termed the *internal language*.

We learn to read by associating the visual appearance of certain symbols with the sound previously acquired of the respective letters and words. These so-called visual memories are also stored in the cerebral cortex, probably in the angular gyrus and its vicinity. When one reads aloud, the words are first recognized by the visual center, which calls up the corresponding sound in the auditory center, from which the motor speech center is stimulated, and the memory of the required muscle-movements necessary to articulate the word is called up. Then through the centers for these muscles in the foot of the precentral convolution (Fig. 99) the word is pronounced. When we read silently, the same process takes place by means of the internal language.

In learning to write the visual perception of the letters is associated with certain muscular movements of the fingers and arms necessary to make them. These memories are kept in the second frontal convolution of the left side (in right-handed people). This center has been termed the writing or cheiro-kinesthetic center. As in writing, each letter is self-dictated by means of either the spoken or internal language, the other centers involved in these

processes are first excited. Reference to Fig. 72 will show the location of the centers mentioned and their probable connections.

From the foregoing it will be seen that while each center has certain functions, these are more or less dependent upon each other. It has been observed that a lesion developing suddenly in one center causes more or less interference in the function of the others; this is especially the case soon after the onset; later, permanent symptoms more closely related to the affected center remain. These early symptoms have been explained by von Monakow to be due to a lowering of functional activity in a more or less distant part of the speech mechanism, due to the upsetting of the balance between the several parts of this mechanism produced by the destruction of one of the integral parts by the lesion. He termed this *diaschisis*.

Classification.—Based on whether the receptive or emissive function is affected, aphasia has been divided into sensory and motor. Sensory aphasia

Fig. 72.—Diagram showing probable pathways of nervous impulses concerned in speech and writing.¹ A, Center for auditory word memories in first temporal convolution; V, center for visual word memories in angular gyrus, G.K., glossokinesthetic center (Bastian), or psychomotor center, at foot of third temporal convolution; U, centers for muscles involved in articulation at foot of central convolution; C.K., probable centers for memory of muscular movements involved in writing (chirokinesthetic center of Bastian); W, centers for controlling muscles of arm and hand in central convolutions, A-A', tract from cortex of temporal lobe (auditory centers) to center for word memories; V-V', tract from cuneus to center for visual memories; W-W', tract from arm and hand centers to cells in anterior horns of cord and peripheral nerves controlling these muscles (pyramidal tract); U-U', tract from centers for muscles of cord and peripheral nerves controlling these muscles (pyramidal tract); U-U', tract from centers for muscles of articulation to centers in pons and medulla and nerves controlling these muscles (pyramidal tract). In speaking, impulses travel from A-G-K-U-U', in reading aloud, from V-A-G-K-U-U', in silent reading, from V-A-G-K, in writing spontaneously, V-A-G-K-W-W', in writing from dictation, A-V-G-K-C-K-W-W', in copying, V-C-K-W-W', N, naming center (?); S, center for stereognostic sense in parietal lobe (Potts).

(Wernicke) is present when, the peripheral apparatus being intact, the patient is either unable to understand the language which he has been accustomed to use or is unable to recognize the meaning of the symbols, either written or printed, with which he was once familiar. In other words, he hears, but the once familiar sounds are to the patient as a foreign language; he sees them, but they look to him as those of a foreign language, and he cannot read understandingly. The former is known as *word-deafness* or *auditory aphasia*, the latter as *word-blindness*, *alexia*, or *visual aphasia*.

Closely related to this is a form termed *optic aphasia*, in which the patient when shown an object with which he was once familiar is unable to call up its

¹ In right-handed persons these centers and tracts are situated in the left side of the brain; in left-handed persons they are situated in the right side of the brain.

name. He is, however, able to pronounce the name when he hears it. This symptom is termed *anomia*, and is probably due to a lesion in the center N (Fig. 72) or one of the tracts, SN, VN, or AN, for the reason that naming an object depends upon the recognition of its visual, auditory, or tactile characteristics. Another is the form known as mind or psychic blindness, in which, in addition to loss of the power of reading, there also is inability to distinguish between objects and persons and to know the proper use of things. This last is known as *apraxia* (p. 1026). Mind-blindness, therefore, is word-blindness plus *apraxia*.

Motor aphasia (Broca's), or *aphemia*, is present when the patient, the peripheral speech apparatus (lips, tongue, larynx) being intact, is unable either partly or completely to give utterance to his thoughts. Loss of the power of writing, not dependent upon paralysis of the muscles, is termed *agraphia*. It is usually associated either with motor aphasia or word-blindness.

When a patient is able to speak and read several languages he may, in some cases, only be aphasic for one of them. He may be able to read letters when he cannot words; printed symbols, when he cannot written ones; figures and not letters, and *vice versa*.

Related to speech is gesture. Loss of the power of understanding or employing gesture is known as *amimia*. Sometimes, either with or without defects of ordinary speech, there is loss of the power in those who once possessed it to either produce or comprehend musical sounds. This is termed *amusia*.

In some cases the patient may be able to speak, but he skips words and uses wrong ones. This is termed *paraphasia* or *conduction aphasia*, being due to a lesion in the tract A-GK, Fig. 72. Aphasia is also divided into cortical and subcortical; the symptoms of each follow:¹

Cortical Auditory Aphasia.—The lesion is at A. There would be loss of the power of understanding spoken words; words could not be repeated or written from dictation. Stimulation of this center being necessary to activate GK, spoken speech would be defective, wrong words used, and paraphasia result. The internal language also being interfered with, the power of reading and writing is defective (tracts V-A-GK, Fig. 72).

Subcortical Auditory Aphasia.—The lesion is in the tract A-A', the center A being intact. The patient is unable to understand spoken words. Reading and writing from dictation are not well performed. Some paraphasia is present, as the patient, when he pronounces a word, is unable by hearing to recognize its correctness. The internal language is intact and word memories can be recalled (A); hence silent reading and writing are not interfered with (tract V-A-GK, Fig. 72).

Cortical Visual Aphasia.—Lesion in center V. There is inability to read (*alexia*) aloud or silently, to write spontaneously, from dictation, or to copy understandingly. Speech is not interfered with.

Subcortical Visual Aphasia.—Lesion in tract V'-V, loss of ability to read and copy understandingly. Through the tract V'-CK he can copy mechanically. The center V being intact, visual memories can be recalled; hence he can write imperfectly, as one with his eyes closed.

Cortical Motor Aphasia.—Lesion in center GK. Spontaneous speech, repeating words, and reading aloud are either completely or partially lost. Owing to the loss of the internal language, the power of silent reading and writing is also lost (V-A-GK, Fig. 72). Language is understood.

¹ As a matter of fact, lesions cannot be as definitely localized as here described. The principle of diaschisis (p. 1024) must be borne in mind in studying aphasics. The subdivision here given seems valuable, however, for purposes of study.

Subcortical Motor Aphasia.—Lesion in tract GK-U. Spontaneous speech, repeating words, and reading aloud are lost. The internal language being intact (A and GK), silent reading and writing are not interfered with. Language is understood.

Two or more of these centers or their connecting tracts may be diseased, and then a combined motor and sensory aphasia will result. (See also p. 1024.)

Marie's Theory of Aphasia.—The above is a presentation of the commonly accepted views upon this subject. In 1906 Marie denied the truth of these views and advanced those entirely different. While these in their entirety have not been generally accepted, a brief mention of them should be made. He believes that the only speech center is the zone of Wernicke, which consists of the supramarginal and angular gyri and the posterior part of the first two temporal convolutions. This region is not one, however, in which sensory images or memories are stored up, but is a purely intellectual center. A lesion in this region causes the symptoms described above, under Sensory Aphasia, and termed by him Wernicke's aphasia. What is generally termed motor aphasia is the above form plus anarthria. Anarthria occurs when the lesion involves the lenticular zone, which is an area comprised between a line passing in a transverse direction from the anterior fissure of the island of Reil to a corresponding point in the lateral ventricle, and a line in a similar direction from the posterior fissure of the island of Reil to a corresponding point of the lateral ventricle. Within this are situated the caudate and lenticular nuclei, the external capsule, the cortex of the island of Reil, and the internal capsule. The anarthria or aphemia of Marie is characterized by loss of speech, with preservation of the understanding of words, of reading, and writing.

Closely related to aphasia are *apraxia* and the *stereognostic sense*.

Apraxia has been divided into sensory and motor, or dyspraxia. In the former, also known as *agnosia*, there is inability to recognize a heretofore familiar object by any one of the senses, and hence there is inability to name it. Thus, if an object is not recognized by sight, there is visual apraxia, or *agnosia*, by hearing, auditory apraxia, or *agnosia*, and so on. Visual *agnosia* is also known as mind-blindness (p. 1025). In the latter the object is recognized, but the patient has forgotten how to use it in the proper way; thus a pencil is recognized and named, but the patient does not know how to use it. These symptoms are usually due to lesions of the left hemisphere in right-handed people. Motor apraxia has been frequently observed when the lesion was either in the first and second frontal convolutions on the left side, parietal lobe, or in the corpus callosum. Variations of this symptom are *parapraxia*, in which the patient when asked to make certain movements, makes others; the *intentional perseveration of Liepmann*, in which he performs the first act requested correctly, but when asked to perform a different one, repeats the first; and the *clonic perseveration of Liepmann*, in which he continues to perform an action for some time after being told to stop. *Stereognostic sense* is the name given to memories preserved in the cerebral cortex (parietal lobe, Fig. 67) of the characteristics of objects by which we are enabled to recognize them without seeing them. Thus, when a person who is blindfolded recognizes that an object placed in his hand is a dollar, he does so by his memory of the peculiar shape, hardness, weight, etc., of previous dollars. The sense depends upon a correlation of tactile, pressure, muscle, and temperature perceptions, and its interpretation by the higher centers (parietal lobe). Loss or diminution of any one of the above forms of sensation causes loss of this sense, which has been termed *astereognosis*, or tactile *agnosia*. Lately it has been proposed to restrict this term to inability to recognize the shape and consistence of objects, while inability to recognize them has been termed *asymbolia*.

Diagnosis of Aphasia.—This depends upon the presence of the symptoms detailed above, the peripheral apparatus being intact. This will serve to differentiate it from speech defects due to paralysis of the muscles concerned in speech, such as occurs in bulbar and pseudobulbar palsy. Motor aphasia is more common than sensory. The condition is usually associated with a right-sided hemiplegia, due to a lesion (thrombosis) in the middle cerebral artery, but may be due to any destructive lesion, as tumor, encephalitis, etc.

Prognosis.—The younger the patient, the better the outlook for some return of speech. Improvement may continue for a considerable time, and eventually fair power return. Many, however, never improve.

Treatment.—This consists of re-education by the same methods as in teaching children to speak, read, and write.

SPINAL LOCALIZATION

This depends upon a knowledge of the location and function of the tracts described on pp. 1012-1014, and of the location of the reflex centers and cells in the anterior horns which control certain muscles (p. 1030). A knowledge of the reflexes is very important. These depend upon the integrity of what is known as a reflex arc. This consists of a sensory nerve, certain cell in the anterior horns, and a motor nerve (Fig. 73). If any part of this arc is functionally interfered with, the corresponding reflex is either diminished or absent. Muscle tone also has considerable to do with reflex action, especially the so-called deep reflexes, as when it is excessive they are increased, and diminished when it is decreased (p. 1013). In this connection it should be remembered that sensory impulses from the muscles are essential to muscle tone, and when they are not received by the brain, as when there is a lesion of the posterior or sensory nerve-roots, muscle tone is diminished. This is especially seen in *tabes dorsalis*. Reflexes are divided into *skin* or *superficial*, *tendon* and *muscle*, or *deep* and *visceral*.

Fig. 73.—Diagram of a reflex arc and course of inhibitory impulses through the pyramidal tract.

SKIN REFLEXES

These are caused by pinching or otherwise irritating the skin, when involuntary muscular contractions occur. This is often an effort to escape from the irritation, and is then known as a "defense reaction." The more important ones are:

The *plantar reflex*, which is brought out by irritating the sole of the foot. Normally under these circumstances the leg is drawn more or less actively toward the body and the toes plantar flexed. In lesions involving the pyram-

VISCERAL REFLEXES

Reflexes of the Eye.—By the *direct light reflex* is meant contraction of the pupil which should occur when the eye is exposed to light, to be followed by dilatation when the light is removed (p. 1051). Modifications of this are *hippus* and the *rebounding pupil*. In the former the pupil, after contracting, will dilate again, doing this alternately a number of times. It may be normal, but usually is seen in mania, meningitis, hysteria, and neurasthenics. The latter consists of contraction followed, while exposed to the same light, by dilatation.

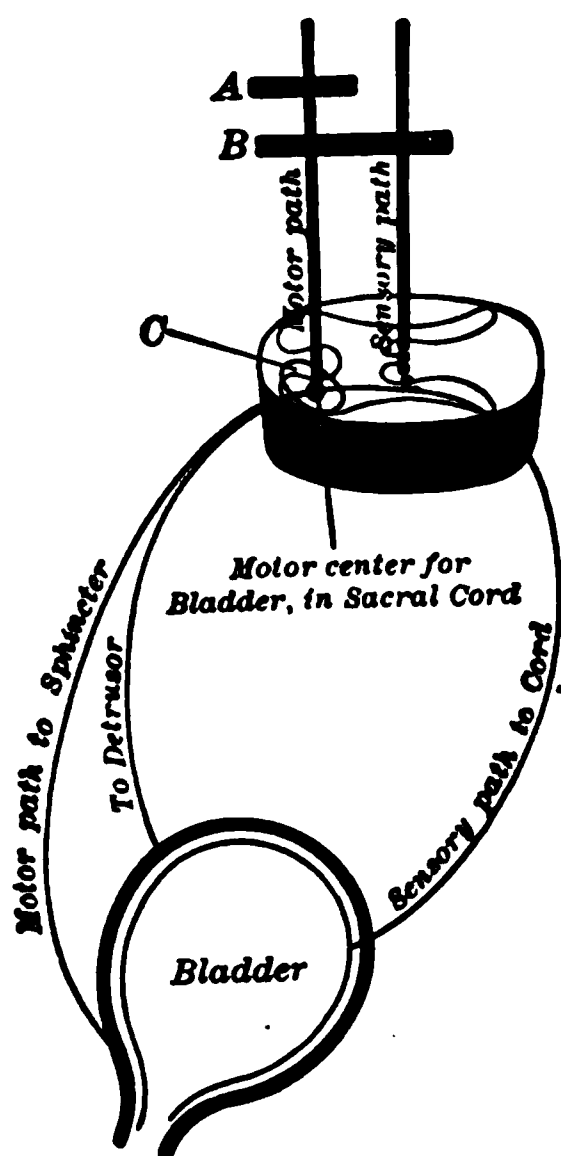


Fig. 74.—Diagram illustrating the innervation of the bladder and the effect of lesions in various parts of the spinal cord upon the function of micturition. A lesion, A, which interrupts the voluntary path to the bladder center in the sacral cord causes incontinence of urine. When a sufficient quantity of urine accumulates in the bladder there occur a reflex contraction of the detrusor and a relaxation of the sphincter. The sensory path from the cord to the brain being uninvolved the patient is conscious of the process, but cannot exercise voluntary control over it. With a lesion, B, which involves also the sensory path, the patient is unconscious of the filling and reflex emptying of the bladder. A lesion, C, which causes destruction of the sacral reflex center of the bladder causes continuous dribbling of urine, and not its automatic expulsion at intervals (Herter).

This is said to indicate retrobulbar neuritis. By the *convergence or ciliary reflex* is meant the pupillary contraction which should occur when looking at a near object, and dilatation when looking at a distant one. Loss of the light reflex with preservation of the convergence is known as the *Argyll Robertson pupil*. This is usually seen as a symptom of tabes dorsalis and paresis. Rarely the phenomena may be reversed. The *pupillary skin reflex* is described on p. 1028.

Reflexes of the Bladder, Rectum, and Sexual Apparatus.—The reflex arc for urination and defecation consists of the pudendal plexus and the third and fourth sacral segments of the cord. These nerves are also connected with the hypogastric plexus and sacral ganglion of the sympathetic system, and this system probably has some influence and may compensate to some extent for loss of function in the arc. When anything interferes with the action of the inhibitory part of the mechanism (pyramidal tracts), voluntary control of urination and defecation is lost; in other words, so soon as the bladder is full, the contents are expelled automatically, just as is normally the case in the infant. If there is weakness of the muscles concerned in urination, a certain

amount of residual urine is left which gradually accumulates until the bladder becomes overfull, the sphincter muscle is overcome, and dribbling of urine occurs. This is known as the *incontinence of retention*. It may occur also in retention due to mechanical causes, as enlarged prostate. If the cord is completely divided, after a period of retention, the contents of the bladder and rectum may be voided at intervals automatically. Sensory irritation of the lower extremities may also cause evacuation of the bladder associated with contraction of the flexor muscles and sweating (the "mass reflex" of Head and Riddoeh¹). When the centers in the cord are involved or the nerve-trunks, there is constant dribbling without previous retention. In this condition also

the anal sphincter will be relaxed and the *anal reflex*, which consists of contraction of the sphincter when the finger is introduced into the rectum, will be lost. When there is merely weakness of the muscles concerned in these functions, there will be difficulty in starting the stream of urine or obstinate constipation. If the sensory tracts of the cord are involved, the patient will not have the sensations peculiar to a full bladder or rectum (Fig. 74). Damage to the reflex arc governing the sexual functions causes loss of the power of erection. Loss of inhibition may cause priapism.

For the purposes of localization of lesions in the spinal cord it is assumed to be composed of thirty-one divisions called segments. Each segment contains reflex, trophic and vasomotor centers, and cells which give origin to motor peripheral nerves supplying certain muscles, and receives peripheral sensory nerve-fibers that receive sensation from certain areas of the skin, etc. Through them also pass the motor tracts conveying impulses from the brain and exercising an inhibitory influence upon the reflexes and sensory

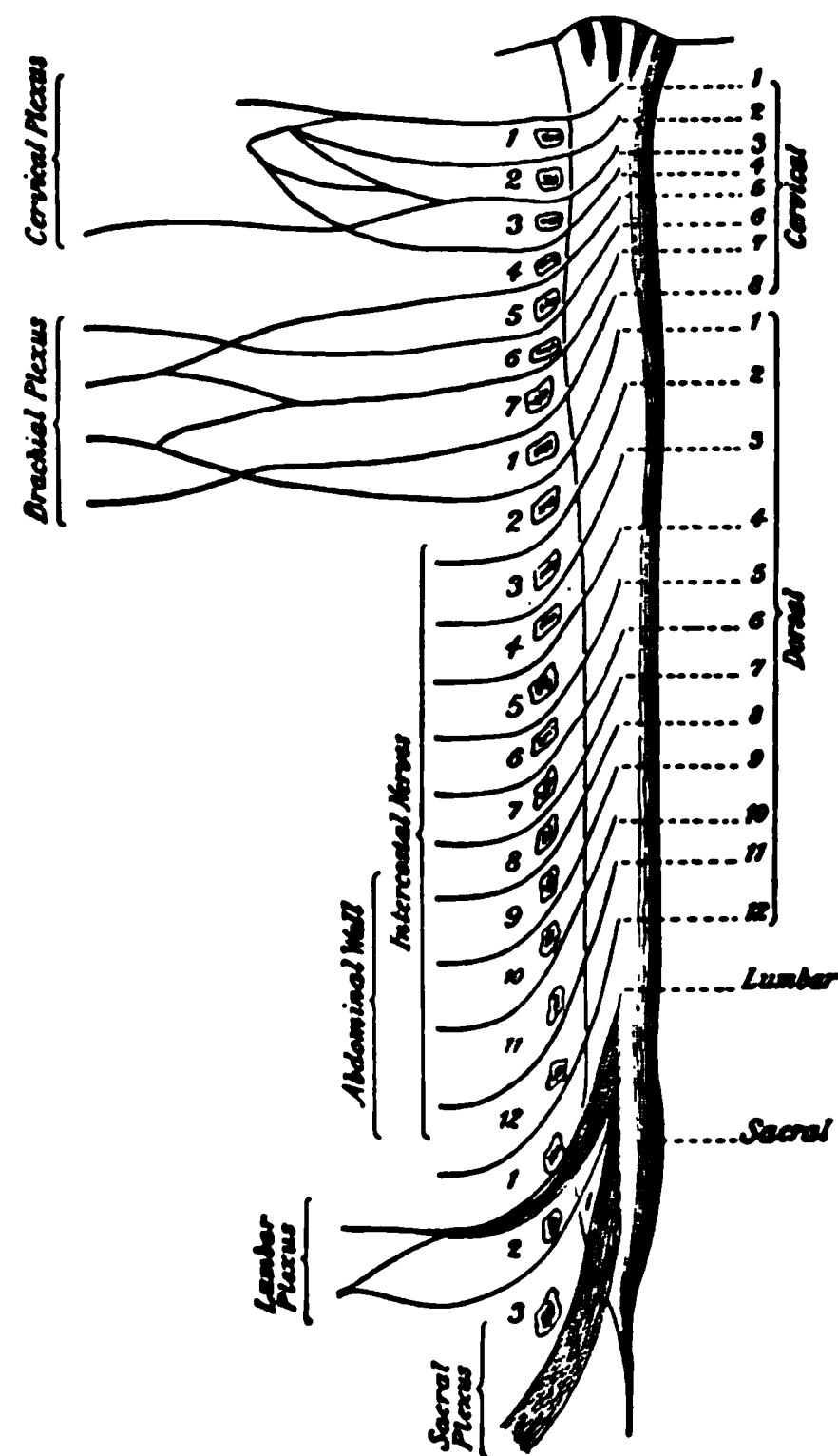


Fig. 75.—Diagram showing the groupings and plexuses of the spinal nerves (redrawn after Baker).

tracts conveying sensory impulses to it. The segments are named according to the peripheral nerve to which they give origin. Thus, the eighth dorsal nerve arises from the eighth dorsal segment.

The most important regions are the cervical and lumbar enlargements. The former (fourth cervical to first dorsal) gives origin to the nerve-roots that form the brachial plexus, and in the latter (first lumbar to the third sacral) originate the nerves that supply the muscles of the legs. The spinal cord ends at the base of the first lumbar vertebra, hence the segments do not correspond in location to the vertebra whose name it bears. The intraspinal course of the nerve-roots before they emerge between the vertebra being longer, the lower their origin from the cord. This causes the roots from the lumbar and sacral regions to pass down through the spinal canal to the respective vertebra between

¹ Brain, 1917, 188.

which they emerge as a bundle known as the *cauda equina*. To determine the relation of the segments to the spinous processes of the vertebræ, in the cervical region add one to the number of vertebra, and this will give the segment opposite. In the upper dorsal region add two, and in the lower dorsal (sixth to eleventh) add three. The lower three lumbar segments are opposite the lower part of the eleventh spinous process and the space below it. The sacral segments are under the twelfth dorsal spinous process and the space below it (Fig. 75).

The following table (Starr, modified by Mills and Dana from the experimental and clinical studies of Thorburn and others) shows the localization of function (not organs) in the different segments of the cord:

LOCALIZATION OF THE FUNCTIONS OF THE SEGMENTS OF THE SPINAL CORD			
Segment.	Muscles.	Reflex and Centers.	Sensation.
First cervical.	Rectus laterales. Rectus capitis. Anticus and posticus. Sternohyoid. Sternothyroid.		
Second and third cervical.	Sternomastoid. Trapezius. Scaleni and neck. Omohyoid. Diaphragm.	<i>Hypochondrium</i> (?). Sudden inspiration produced by sudden pressure beneath the lower border of the ribs.	Back of head to vertex and neck. (Occipitalis major, occipitalis minor, auricularis magnus, superficialis colli, and supraclavicular.)
Fourth cervical.	Diaphragm. Deltoid. Biceps. Coracobrachialis. Supinator longus. Rhomboid. Supra- and infraspinatus.	<i>Pupillary</i> (fourth cervical to second dorsal). Dilatation of the pupil produced by irritation of the neck.	Neck. Shoulder, anterior surface. Outer arm. (Supraclavicular, circumflex, external musculocutaneous, cutaneous.)
Fifth cervical.	Deltoid. Biceps. Coracobrachialis. Brachialis anticus. Supinator longus. Supinator brevis. Deep muscles of shoulder-blade. Rhomboid. Teres minor. Pectoralis (clavicular part). Serratus magnus.	<i>Scapular</i> (fifth cervical to first dorsal). Irritation of skin over the scapula produces contraction of the scapular muscles. <i>Supinator longus</i> . Tapping the tendon of the supinator longus produces flexion of forearm. <i>Biceps</i> (fifth cervical).	Back of shoulder and arm. Outer side of arm and forearm to the wrist. (Supraclavicular, circumflex, external cutaneous, internal cutaneous, posterior spinal branches.)
Sixth cervical.	Deltoid. Biceps. Brachialis anticus. Subscapular. Pectoralis (clavicular part). Serratus magnus. Triceps. Pronators. Rhomboid. Latissimus dorsi.	<i>Triceps</i> (fifth to sixth cervical). Tapping elbow tendon produces extension of forearm. <i>Posterior wrist</i> (sixth to eighth cervical). Tapping tendons causes extension of the hand.	Outer side and front of forearm. Back of hand, radial distribution. (Chiefly external cutaneous, internal cutaneous, radial.)
Seventh cervical.	Triceps (long head). Extensors of wrist and fingers. Pronators of wrist. Flexors of wrist. Subscapular. Pectoralis (costal part). Serratus magnus. Lattissimus dorsi. Teres major.	<i>Anterior wrist</i> (seventh to eighth cervical). Tapping anterior tendons causes flexion of wrist. <i>Palmar</i> (seventh cervical to first dorsal). Stroking the palm causes closure of the fingers.	Radial distribution in the hand. Median distribution in the palm, thumb, index, and one-half of the middle finger. (External cutaneous, internal cutaneous, radial, median, posterior spinal branches.)
Eighth cervical.	Triceps (long head). Flexors of wrist and fingers. Intrinsic hand muscles. Extensors of thumb. Intrinsic hand muscles. Thenar and hypothenar muscles.	Ulnar area of hand, back, and palm, inner border of forearm. (Internal cutaneous ulnar.)
First dorsal.	Chiefly inner side of forearm and arm to near the axilla. (Chiefly internal cutaneous and nerve of Wrisberg or lesser internal cutaneous.)
Second dorsal.	Inner side of arm near to and in the axilla. (Intercostohumeral.)

LOCALIZATION OF THE FUNCTIONS OF THE SEGMENTS OF THE SPINAL CORD

Segment.	Muscles.	Reflex and Centers.	Sensation.
Second to twelfth dorsal.	Muscles of back and abdomen. Erectores spinae.	<i>Epigastric</i> (fourth to seventh dorsal). Tickling in a m m a r y region causes retraction of the epigastrium. <i>Abdominal</i> (seventh to eleventh dorsal). Stroking side of abdomen causes retraction of belly. Vasomotor centers. Second dorsal to second lumbar.	Skin of the chest and abdomen, in bands running around and downward, corresponding to spinal nerves. Upper gluteal region. (Intercostals and dorsal posterior nerves.) Eleventh and twelfth dorsal, testicle.
First lumbar.	None.	<i>Cremasteric</i> (first to third lumbar). Stroking inner thigh causes retraction of scrotum.	Skin over groin and front of scrotum. (Ilio-hypogastric, ilio-inguinale.) Testicle.
Second lumbar.	Vastus internus.	<i>Patellar</i> . Striking patellar tendon causes extension of the leg.	Outer side and upper front of thigh. Lumbar region. (Genitocrural, external cutaneous.)
Third lumbar.	Sartorius; adductors of thigh.		Front and outer side of thigh. Inner side of leg and foot.
Fourth lumbar.	Flexors of thigh. Extensors of knee. Abductors of thigh.	<i>Gluteal</i> (fourth to fifth lumbar). Stroking buttock causes dimpling in fold of buttock.	Inner side of thigh, leg, and foot. (Internal cutaneous, long saphenous, obturator.)
Fifth lumbar.	Outward rotators. Flexors of knee. Flexors of ankle. Peronei. Extensors of toes.	<i>Achilles tendon</i> . Overextension causes rapid flexion of ankle, called <i>ankle-clonus</i> .	Back of thigh and outer side of leg and ankle; sole; dorsum of foot. (External popliteal, external saphenous, musculocutaneous, plantar.)
First and second sacral.	Calf muscles. Glutei. Peronei. Extensors of ankle. Small muscles of foot.	<i>Plantar</i> (fifth lumbar to second sacral). Tickling sole of foot causes flexion of toes and retraction of leg.	Back of buttock and thigh, side of leg and ankle; sole; dorsum of foot.
Third, fourth, and fifth sacral.	Perineal. Muscles of bladder, rectum, and external genitals.	Genital center. Vesical center. Anal center.	Circumanal region, anus, rectum, penis, urethra, vagina, perineum. Skin of posterior surface of scrotum. (Small sciatic, pudic, inferior hemorrhoidal, inferior pudendal.)

To the foregoing table, which illustrates spinal localization, should be added another, showing what functions reside in the pons and medulla, as follows:

- Nuclei.*
- III. { Sphincter iris. Ciliary muscles.
Levator palpebræ superioris. Rectus internus (in convergence).
Rectus superior. Rectus inferior.
 - IV. { Obliquus inferior.
Obliquus superior.
(Upper facial group.)
 - V. { (Associated movement of levator palpebræ.)
Muscles of lower jaw.
 - VI. { Rectus externus. Rectus
inter. of opposite side
in lateral movements.
 - VII.—Facial muscles.
 - IX. { Muscles of pharynx.
 - X. { Muscles of esophagus.
 - XI. { Muscles of larynx.
(Motor cortical area, see p. 1017.)
 - XII. { (Lower facial group.)
Muscles of tongue.

The skin areas innervated by the different segments are shown in Fig. 76. A true segmental type of anesthesia only occurs when the posterior spinal roots are involved. If the roots are irritated there may be a zone or area of

peresthesia or shooting pains in the course of the nerves arising from these roots—root pain (pp. 1035, 1078, 1099, 1151).

Certain groups of symptoms indicate lesions in certain regions. Thus, a lesion in the cervical segments will cause more or less paralysis of the arms, according to its location, and if transverse, motor paralysis of the central neuron type and sensory paralysis below the seat of the lesion. This is due to the fact that motor impulses will be unable to pass by way of the motor tracts through the diseased area, and sensory impulses will be unable to pass by way of the sensory tracts from the periphery to the brain. The paralyzed muscles supplied by the involved segments will show the characteristics of the peripheral neuron type (p. 1013). If in the dorsal segments, there will be motor

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Fig. 75.—Showing the regions innervated by the different spinal roots or the corresponding segments of the cord. It should be remembered that the limits are not in reality so sharply defined, but extend into another (Koehler).

paralysis of the central neuron type and loss of sensation below the seat of the lesion. In the lumbar segments the muscles supplied by those affected will show a peripheral type of paralysis, below it will be of the central neuron variety. The area of anesthesia will depend for its upper limit upon the segments involved (fig. 76).

Sensory loss extending to the umbilicus means a lesion involving as its upper limit the *ninth dorsal* segment; if one inch below this, the *tenth*. When this segment is involved, if the patient attempts to raise the shoulders from the bed, the umbilicus will be pulled upward. This is due to the fact that the upper part of the rectus muscle is not paralyzed, while the lower is. The nipples correspond to the *fourth dorsal* segment.

If the *fifth cervical* is involved alone, the biceps, brachialis anticus, deltoid, and supinator longus are paralyzed, the other muscles of the arm and shoulder escaping. The biceps-jerk will be lost and the triceps-jerk present. When the *sixth cervical* is thus involved, the fifth escaping, these muscles are not involved and the arms will be in the position of abduction from the body, the forearms flexed on the arms and in the supine position. The biceps-jerk will be present and the triceps lost. Certain parts of the cord are known as the *epi-conus* and *conus*. Symptoms indicating lesions in these locations and in the *cauda equina* are given on p. 1102.

Owing to the arrangement of the various tracts of the spinal cord a lesion involving its lateral half causes a peculiar combination of symptoms, frequently termed Brown-Séquard's paralysis.

It is met with particularly as a result of injuries (knife-thrusts and the like), though it may also be due to tumor or caries of the cord, to syphilis, or to any process causing compression of one-half of the cord. Such lesions intercept the motor impulses of the same side; the fibers having crossed in the medulla, the sensory fibers, conducting pain and temperature impressions, cross in the cord soon after entering, and hence these forms of sensation will be absent on the side opposite to the lesion; tactile sensation may also be abolished, but in some cases is not (*vide* Fig. 77). A lesion in the cervical cord above the arm nuclei causes motor paralysis of both arm and leg of the same side (spinal hemiplegia) and sensory paralysis on the opposite side. If in the dorsal or lumbar cord, the leg on the corresponding side is paralyzed, while that of the other is anesthetic. Lesions are seldom strictly confined to one side of the cord, but overlap a trifle, so that there is apt to be some loss of power on the anesthetic side; this, however, may be due to the recussation of a few motor-fibers at a lower level. The side of the lesion may be hyperesthetic. Muscular sense is diminished or lost on the same side. Above the hyperesthetic region a zone of anesthesia commonly exists, and above this, again, an area of hyperesthesia. The reflexes are increased on the side of the lesion (inhibition being removed), and the temperature of that side is usually higher. On the anesthetic side the motor power, reflexes, muscle sense, and temperature are all normal.

GENERAL SYMPTOMATOLOGY

Information on this subject will also be found in the sections on Cerebral and Spinal Localization and on pp. 1017, 1027.

Nervous diseases are usually spoken of as being either *functional* or *organic*; but, as our methods of research become more refined and our technic more perfect, the breach between these two groups is being gradually but steadily lessened.

Organic nervous diseases may be produced by two types of lesions:

1. *Irritative*, causing an increase of function, continuous or intermittent.
2. *Destructive*, resulting in paralysis of motion or sensation, or both.

Irritative lesions are prone to become destructive in course of time.

When a complete pathway is involved a system disease is said to be produced. Thus the disease known as amyotrophic lateral sclerosis (p. 1105), in which the lesion is a degeneration confined to the motor tracts, is one of this type. When two or more paths or neuron complexes are simultaneously involved combined system disease results.

Brain lesions may be (a) focal or (b) diffuse. Cord lesions are either (a) transverse, (b) focal, or (c) insular (a series of foci).

Cord lesions result in ascending or descending degeneration, the destructive process traveling, as a rule, in the direction in which impulses are normally transmitted. In the fillet degeneration may extend up or down.

The following may be accepted as a general rule: the motor nervous system is the last to develop, the first to lose, and the last to regain, its function; while the sensory nervous system is the first to develop, the last to lose, and the first to regain, its function. In making a diagnosis it is, therefore, of the utmost importance to try to determine the locality and extent of the morbid process, and to ascertain whether the lesion is a focal or systemic one. The symptomatology of system diseases is pretty constant, and, except in their very incipency, they are usually not difficult of diagnosis. The symptoms of focal diseases, on the other hand, vary, of necessity, according to the location of the focus. They are often difficult and at times impossible to diagnose.

Irritative motor lesions produce, according to the degree of irritation, either fibrillary muscular twitchings or mild or severe convulsions, tonic or clonic in character (p. 1018).

Destructive motor lesions, according to their extent, produce mere muscular weakness, paresis, or actual paralysis of a single muscle, groups of muscles, or of the entire musculature of one or more limbs.

Irritative sensory lesions give rise to pain, paresthesia, hyperesthesia, or hyperalgesia.

Pain is a very important symptom. Sharp and shooting pains may indicate irritation of the posterior nerve-roots (root-pain) or a symptomatic neuralgia (p. 1037). The feeling of a tight band about the body (girdle-pain) also denotes irritation of posterior nerve-roots. General hyperesthesia and pain occur in spinal meningeal irritation. Pain in the back aggravated by jarring is characteristic of vertebral disease. Burning pain is often due to neuritis. Backache may be due to neurasthenia, hysteria, or myelitis.

A very important form of pain is *headache*. This may be due to a number of different causes not connected with the nervous system, and may be located in different parts of the head, which often have a relation to the cause. It differs from neuralgia in not being confined to the distribution of particular nerves, although the seat of the pain is in the branches of the fifth nerve in the meninges. The important causes are:

1. *Reflex Irritation*.—Ocular (eye-strain or inflammation or commencing glaucoma); disease of the nasal cavity and accessory sinuses; middle-ear disease; diseased teeth; disease of the pelvic, thoracic, or abdominal viscera.

2. *Toxemia*.—These comprise infections, as the prodromes of infectious diseases, malaria, and syphilis before secondary symptoms appear; metabolic disturbances and diminished elimination, as uremia, diabetes, gout, hepatic disease, constipation, and exophthalmic goiter; action of drugs and poisons, as alcohol, tobacco, tea, coffee, lead, nitrites, quinin, carbon monoxid, opium.

Circulatory Disturbances.—Passive hyperemia due to disease of the right side of the heart, pressure on veins, emphysema; active hyperemia, as in the beginning of acute meningitis; anemia due to loss of blood, idiopathic anemias, or disease of the heart or arteries which prevents sufficient blood from reaching the brain, as arteriosclerosis.

Neuroses, as hysteria, neurasthenia.

Organic Disease of the Brain and its Membranes.—Tumor, abscess, meningitis due to syphilis or other cause, encephalitis.

Caries of the Cranial Bones.—*Indurative* or *muscular*, due to so-called rheumatic nodules in the muscles of the scalp and neck.

Migraine (p. 1161).

The diagnosis of the cause depends upon careful study of the case. Headache due to cerebral syphilis is usually much worse at night. If due to circula-

tory disturbance it is often throbbing and made worse by either raising or lowering the head, according to whether hyperemia or anemia is the cause. Pain due to eye-strain is brought on by using the eyes. It is either supra-orbital or occipital. When due to disease of the frontal sinus the pain is throbbing, usually appears after the patient has arisen, and passes off toward evening. It is aggravated by coughing or lowering the head. In indurative headache the muscles are tender and often nodules will be felt in them. It frequently comes on after exposure to cold winds or washing the hair.

The treatment of headache depends largely upon the cause. Relief may be obtained by using the various coal-tar analgesics, as phenacetin, acetanilid, etc. Caffein is often of service in those due to neurasthenia or mental exhaustion from any cause. Local applications, as menthol rubbed over the forehead, inhalation of carbonate of ammonia (smelling-salts), or heat applied to the head, may be of service.

Indurative headaches should be treated by some form of salicylic acid, vibratory massage, and the high-frequency current over the muscles of the neck and scalp.

Destructive sensory lesions cause a more or less complete absence of sensation, as analgesia, anesthesia, or loss of temperature sense.

By the term "analgesia" is meant loss of the sense of pain, by "anesthesia" is meant loss of the sense of touch. The prefix "hyp" preceding these words means diminished but not complete loss of sensibility. It is

Fig. 77—Scheme representing cord lesion and effects in Brown-Séquard paralysis (after Brissaud) *CSG*, Left sensitive tract, *CSD*, right sensitive tract. *A, B, C, D*, lesion involving the left half of the cord, *S, S, S*, sensory roots from right side of body, *Z, Z, Z*, sensory roots from left side of body, *Z¹, Z²*, and *S*, are irritated only at the points *A, B, C*, and their peripheral area is hyperæsthetic, *Z³* is divided and its skin area is anæsthetic on the same side as the lesion. Corresponding to *S* and all the roots below arising from the right side of the body, there is anæsthesia.

important to remember that pressure may be felt when tactile sense is lost. Therefore in testing for the presence or absence of tactile sensibility, as little pressure as possible must be made. The peripheral nerves contain three sets of fibers (Head, Rivers, and Sherren; *Brain*, 1905) as follows:

1. Those which subserve deep sensibility and conduct the impulses produced by pressure and movement of limbs. The fibers of this system run mainly with the motor nerves and are not destroyed by division of the sensory nerves of the skin. These fibers also are located in the tendons. If pressure is severe enough pain may be caused.

2. Those which subserve *protopathic sensibility*, i. e., painful stimuli and extremes of heat and cold, but inability to localize the spot stimulated.

3. Those which subserve *epicritic sensibility*, i. e., the power of cutaneous localization, of the discrimination of two points, and of the finer degrees of temperature, as cool and warm. Protopathic sensibility returns first after a sensory nerve has been injured.

If the tracts conveying sensations from the muscles and tendons are not functioning, loss of *muscle sense* results, *i. e.*, inability to recognize the direction of active and passive movements and the position of the extremities. One of these may be lost without the other.

The use of the electric current gives important information in distinguishing between motor paralysis due to a central neuron lesion and a peripheral (p. 1013). In that due to lesions of the former the muscles respond to both the faradic and constant currents, the contraction being characterized by a sharp, quick jerk of the muscle, which in the case of the constant current occurs first when the cathode or negative pole is placed over the muscle being tested or treated. If of the latter, there is either a diminution or loss of faradic contractility, and at first an increase in the contraction caused by the constant current, which may become diminished later. The contraction instead of being quick is *slow* and *tetanic* in character, and in some cases the weakest current that will cause contraction is when the anode or positive pole is placed over the muscle. This, known as the serial change, is not always present. If it is, it may be indicated by the following formulæ:

Normal: $KClC > AnClC$.

Abnormal: $AnClC > KClC$ or $AnClC = KClC$.

Lesions of this neuron, if very mild, may not cause any change in the electric reactions, except possibly some lessening of faradic contractility.

Neuralgia, *headache*, *vertigo*, and *nystagmus* are symptomatic conditions of importance (*vide*).

I. DISEASES OF THE PERIPHERAL NERVES

NEURALGIA

Definition.—Neuralgia (*nerve-pain*) is a term used to denote painful sensations that have the following characteristics: 1st. In their distribution they follow the course of the nerve-trunks or their branches. 2d. They show a tendency to shift from place to place. 3d. There are painful points (*points douloureux*) along the course of the nerve-trunks. 4th. Intermision and remission of the pain. 5th. There are no constant objective signs and no constant morbid changes in the nerves. True neuralgia is, therefore, a functional condition, and a symptom produced by a number of different causes.

Any nerve in the body may be affected. Quite often one can find no definite cause of the neuralgia. A number of cases classified as such are due either to a mild perineuritis or to disease of the root ganglion, as in herpes zoster. In many of these it may be difficult to make a differential diagnosis if the process is not severe enough to interfere with the function of the nerve, and such cases may be classified with the neuralgias.

Etiology.—Anemia from any cause; toxemia, which may be of exogenous origin, as from lead, arsenic, mercury, copper, alcohol, tobacco, tea, coffee, any of the infectious diseases, or endogenous, as diabetes and nephritis; the deprivation of either morphin or cocain in a habitué; reflex, as the referred pains of visceral disease, thus a sciatica may be due to prostatic disease, neuralgic pain in the distribution of the sixth dorsal nerve may be due to heart disease, and so on¹; heredity, neuropathic, gouty, and scrofulous individuals being especially liable; exposure to cold and wet; chronic vascular disease, es-

¹ These relations have been studied and classified by Henry Head, *Brain*, 1893, p. 1; 1894, p. 23; 1896, p. 153.

pecially arteriosclerosis. The early stages of involvement of nerve trunks from pressure of tumors, especially neuromata, aneurysm, fractures, exostoses, displacements of bones, etc.; irritation, as from decayed teeth (p. 1039), etc.; general impairment of health, as in neurasthenia.

General Symptomatology.—The neuralgic attack may be of sudden or slow onset, with or without prodromata. When the latter exist they consist of a sense of uneasiness, perverted sensations, chilliness, and stinging or slight burning pains. The pain is usually of a paroxysmal, darting, boring character, radiating into the distribution of the affected nerves. In the intervals there may be either dull pain or freedom from it. In the case of the reflex neuralgias the area supplied by the affected nerve-roots is the seat of the pain. It is apt to be increased by movements of the affected parts, drafts, or excitement. Tenderness may be found over certain points, especially where the nerve emerges from a bony canal (points of Valleix); these are not always present. The affected part is usually hyperesthetic; occasionally, however, it is anesthetic, and may continue so for some time after an attack.

Reflex muscular contraction may be present in proportion to the intensity of sensory irritation. Vasomotor symptoms manifest themselves in the flushing or blanching of the affected part and in increased secretions, as sweating.

Trophic disturbances may result in temporary or permanent changes. To the former belong the herpetic and urticarial eruptions, while the latter groups include change of color in, loss of, or overgrowth of the hair, various changes in the skin (as pigmentation and morphea, and even ulceration, though in the latter instance there is probably a more profound pathologic change than that which we regard as the cause of neuralgia). Unless the attacks are severe or prolonged, however, the general system seldom suffers.

Diagnosis.—Neuralgia must be distinguished from *neuritis*, a mild attack of which, as has been said, it may resemble very closely. So much so, in fact, that in some cases the distinction cannot be made. Whenever the function of the nerve is interfered with, as shown by motor weakness, constant diminution of sensibility, absent or diminished reflexes, tenderness along the nerve-trunk, and wasting of the muscles, neuritis is present. Headache is distinguished by the fact that the pain is more or less diffuse, and is not paroxysmal and shooting in type. It must be remembered that pain of a neuralgic type may occur in diseases of the cranial or spinal bones, tumor of the cord or its membranes, tabes dorsalis, multiple sclerosis, syringomyelia, meningomyelitis, basal meningitis, cervical pachymeningitis, tumor of the cerebellopontile angle, of the gasserian ganglion, and inflammation of the sensory root ganglia, either cranial or spinal. The diagnostic points will be detailed under their respective headings.

Prognosis.—This depends upon the cause, whether removable or not; some forms, especially those of the fifth and sciatic nerves, are very intractable (p. 1039). There is always the danger in chronic cases of a drug habit being formed.

Certain types, as of the fifth (p. 1039) and sciatic nerves (p. 1042), require special mention.

Treatment.—The first requisite in the treatment of neuralgia is to ascertain whether it is due to local or general causes. That of the former class may be caused by a cicatrix, neuroma, aneurysm, neoplasm, or by caries or traumatism; and the treatment must necessarily be directed toward the removal of the cause when possible. When the fault is a general one, the neuralgia may occur either as the immediate result of the systemic disease or, remotely, as the result of the altered blood state (anemia). This is particularly well illustrated by an attack of malaria, in which it is obvious that success

can only be obtained by attention to the underlying cause. It is sometimes necessary to use an analgesic, of which morphin is certainly the best. Its therapeutic value is most decided when the drug is given hypodermically, and, if injected directly over the track of the painful nerve (*e. g.*, supraorbital branch of the fifth), it not only affords immediate relief, but also obviates recurrences of the painful paroxysms in many instances. It is, however, scarcely necessary to urge the exercise of caution, for the morphin-habit is readily formed in these cases. The following may also be used: antipyrin, phenacetin, codein, veratrum viride, aconite, also counterirritants and vesicants, including the galvanic current, which is applied by placing the anode over the tender spots if they exist, otherwise over the seat of the pain. A rapidly interrupted faradic current applied over this area and the high-frequency current may also prove valuable. The general tone of the system must be attended to, bad habits prohibited, the state of the bowels regulated, and the eyes examined and corrected for errors of refraction. Rest is a valuable adjunct to any form of treatment. In severe neuralgia of either the brachial or lumbosacral plexus division of the posterior roots has been practised with varied success. (See also p. 1040.)

NEURALGIA OF FIFTH NERVE OR TIC DOULOUREUX

This is a neuralgia involving one or more of the branches of the nerve. It varies greatly in character and intensity in different cases, and in its severest forms is one of the most terrible of all the diseases of the nervous system.

The *pathology* is doubtful. In those cases that have been subjected to surgical operation, excised portions of the nerves sometimes were normal and sometimes contained a moderate number of degenerated fibers. In other cases in which the gasserian ganglion has been removed and examined, considerable sclerosis of the blood-vessels has been detected, alterations in the axis-cylinders of the nerves, and occasionally moderate changes in the ganglion cells. It is not known exactly how these lesions produce the symptoms, but it is probable that vascular alterations are exceedingly important.

The *etiology* is various. Neuropathic heredity appears to play an important part. It is more frequently a disease of late than of early life. Peripheral irritation is frequently found, and when removed often results in complete cure. Among the structures disease of which is a frequent cause of neuralgia of the fifth nerve are the nose and the cavities entering into it, and the mouth. Lesions of the former structures comprise chronic irritations, spurs, occlusion of the nasal openings, and suppuration. In the latter, abscesses at the roots of the teeth, irritated pulp, and occasionally, either non-eruption or malpositions of the teeth, are among the exciting factors. It is possible that eye-strain may also be an exciting cause.

The *symptoms* may be variable in extent, duration, and intensity. In the mild form there is only an occasional paroxysm, limited to one of the branches of the nerve, such as the type that occurs in acute coryza. In the more severe form there may be repeated paroxysms, the intervals varying from a few minutes to several days, involving the whole side of the face, and causing, for the time being, complete prostration on the part of the patient. The pain is often radiating, or of a rending or boring character, and sometimes so severe as to cause nausea. It is often accompanied by certain vasomotor or secretory phenomena, such as flushing, perspiration, or excessive tear production, and even in some cases more or less persistent edema of the skin. In some instances there may be more or less twitching of the facial muscles. The duration of the attacks varies greatly. The paroxysms may succeed each other frequently for long periods of time, or until the patient becomes insane or commits suicide; in other cases, after a few paroxysms, the attack passes off and

may not return for months. In some instances the pain is persistent, and although in these cases it is rarely severe, the discomfort of the patient is sometimes greater. The painful points are: for the first branch, the supra-orbital foramen; for the second, the infra-orbital foramen; for the third, the mental foramen. Often the surrounding portions of the skin, particularly those where the periosteum is near the surface, are tender. If the disease continues for some time there may be trophic changes, such as the formation of ulcers, drying of the skin, and the appearance of gray hairs. Sluder¹ has described a neurosis of the sphenopalatine or Meckel's ganglion. The symptoms of the neuralgic type consist of pain more or less intense which may be located over the front of the nose, in and about the eyes, over the frontal region, into the pharynx and tonsil region, in and around the ear, into the occiput, shoulder, arm, and at times even to the fingers. It is apt to be most severe at a point 6 mm. back of the mastoid. It may either be associated with or follow disease of the accessory sinuses or be due to infectious disease, as influenza or focal infection.

The *diagnosis* may have to be made from tumor involving the gasserian ganglion or one in the cerebellopontile angle. The former can be distinguished by the existence of anesthesia in the fifth nerve distribution, the pain is usually constant instead of paroxysmal, and there is often paralysis of the muscles of mastication. The diagnostic points of the latter are given on p. 1133. Bulbar tabes (p. 1153) may also cause pain in the course of the fifth nerve. Neuralgic pain in front of the auricle and within the meatus may be due to disease of the geniculate ganglion or intumescencia gangliiformis (p. 1061). A skiagram will show the existence of non-erupted teeth.

The *prognosis* depends largely upon the cause. In the so-called idiopathic cases it is exceedingly unfavorable.

The *treatment* consists first in the removal of the cause, if it can be found. The eyes, nose, and mouth should be carefully examined, and any source of irritation thoroughly removed. For the treatment of the paroxysms, if they are mild, the coal-tar analgesics may be employed. If severe, the only drug that is at all effective is morphin, which is preferably given hypodermically. Of course, in nearly all instances, if the disease is chronic, the patient becomes addicted to the use of this drug. Occasionally, the external application of a mixture of the ointments of opium and belladonna has proved of service. Strychnin, in full doses, combined with complete rest and liquid diet, aconitin, nitroglycerin in old people in full doses, have sometimes rendered the attacks milder and less frequent. They should be given hypodermically. Salicylates may also prove useful. The general health of the patient should be improved if possible, and the disease treated expectantly for some time. The galvanic current, the anode being placed over the painful areas and given without interruption, may sometimes prove useful. Formerly, section of the painful nerve branch was employed, and even resection of a portion of the nerve, but the results were either so trifling or so transient that in recent years the tendency has been to resort more frequently to the excision of the gasserian ganglion. This is a serious operation; nevertheless, it is often wiser to employ it early rather than to delay until the patient is exhausted by long suffering. Spiller has suggested the section of the sensory root of the ganglion, and this operation gives the same results as excision of the ganglion. A satisfactory method of treatment, especially in old people or those whose general nutrition is poor, if medical methods fail, is the injection of alcohol into the region of the foramina rotundum or ovale, according to the branch affected.² By this plan relief for several years at least may be obtained. The ophthalmic division cannot be

¹ *Jour. Amer. Med. Assoc.*, August 23, 1919, p. 591.

² *Ibid.*, January 20, 1912, p. 155.

injected safely, the supra-orbital branch may be. Attempts with some success have also been made to inject the gasserian ganglion.¹ When the pain is confined to the supra-orbital nerve large doses of quinin may be of service. If due to sphenopalatine ganglion disease the nose and sinuses must be carefully examined and treated if necessary. Foci of infection, dental or otherwise, removed. Injection of the ganglion with 5 to 15 minims of a 2 per cent. solution of carbolic acid in alcohol will often relieve the condition for a number of months at least.²

NEURALGIA OF THE NECK AND TRUNK

The cervical branches of the dorsal and lumbar nerves are involved in this group.

1. *Cervico-occipital neuralgia*, occurring in the occipital and posterior parietal region, is apt to be quite severe, but when not due to spondylitis (the result of caries) or neoplasms the prognosis is fair. It is sometimes the result of direct pressure, as in carrying heavy loads on the neck and shoulders. The painful spot is found between the mastoid process and upper cervical vertebræ. Falling of the hair may also occur. This is much more apt to take place, however, when the occipitalis minor is involved, as it is said that the latter is generally a syphilitic neuralgia.

2. *Intercostal Neuralgia*.—The middle intercostal nerves are most liable to be affected, and generally on the left side. The posterior dorsal branches are seldom involved. When specially severe and persistent, intercostal neuralgia may be a symptom of disease of the cord or its membranes, aneurysm of the aorta, neoplasms, or disease of the vertebræ or ribs. Traumatism and cold also give rise to it. This form of neuralgia is most common in women, the painful spots being at the extremity and at the middle of the ribs. The pain is of a sharp, lancinating character and radiates along the nerve. It is intensified by all movements of the chest; hence the affected side is more or less fixed. Herpes may develop, but in such cases it is probable that an inflammation of the root ganglion exists (p. 1092).

3. *Mastodynia* is really a variety of intercostal neuralgia, and occurs almost solely among women. It is very painful and gives rise to the development of tender "lumps" in the breast, simulating malignant disease. The paroxysms are often accompanied by vomiting.

4. *Lumbo-abdominal neuralgia* is not a common form. The pain is chiefly in the lumbar region, though the hypogastrium, genitals, and buttocks may also be involved.

NEURALGIA OF THE EXTREMITIES

Cervicobrachial neuralgia occurs in the distribution of the four lower cervical nerves. When the condition is bilateral we should look for disease of the cord or its membranes, especially tabes, for new growths in either the spinal canal or bones of the arm, or for disease of the vertebræ. When unilateral, any of the causes already enumerated may be operative; also angina pectoris, referred pain as from gall-stones, cervical rib and a primary or radicular neuritis. The radial and ulnar nerves are more frequently affected than the median. The pain is most apt to be distributed along the whole course of the nerve, but painful points are found in the following situations: in the axilla; over the brachial plexus; on the shoulder, where the cutaneous branches of the circumflex nerve emerge through the deltoid muscle; about the middle of the

¹ *Jour. Amer. Med. Assoc.*, May 3, 1913, p. 1354; November 4, 1916, p. 1357.

² *Ibid.*, August 23, 1919, p. 593.

acid preparations, as a 25 per cent. ointment of mesotan, may also be of service. In old people with arteriosclerosis full doses of nitroglycerin and potassium iodid may give relief. In severe chronic cases electricity, as mentioned above, and counterirritation, preferably by means of a succession of small fly-blisters along the course of the nerve, is of great value. When all else fails, stretching the nerve after exposing it often cures, but sometimes aggravates, the symptoms. The bowels should always be kept free. The deep injection of guaiacol (m̄j to ij—0.066—0.1332) in association with chloroform (m̄x—0.666) has yielded very encouraging results in my hands. Excellent results have been reported from deep perineural injections of salt solution.

Neuralgia of the Genitalia and Rectum.—These varieties are not met with frequently. The former is sometimes a symptom of stone, prostatic disease, or stricture, and in women ovarian and uterine neuralgias are generally hysteric manifestations. Coccygodynia, unless of traumatic origin, is almost solely found in women. The pain in the region of the coccyx is excruciating at times, and may even call for operation.

Visceral Neuralgia.—As implied by the name, these forms are neuralgias resident in the various viscera. They most frequently attack the stomach or bowel, and are recognized as colic. Other viscera may also be involved (liver, kidney). Such pains may be simulated by tabetic crises (p. 1151).

NEURITIS

Definition.—An inflammation of a nerve or of its fibrous envelope.

It may be confined to a single nerve, termed *local neuritis*, or a number of nerves may be affected, when it is termed *multiple* or *polyneuritis*.

Pathology.—The inflammation may be chiefly confined to the sheath of the nerve (perineural) or may, in addition, involve the deeper portions of the sheath (endoneurium), in which an accumulation of lymphoid elements will be found between the nerve-bundles. This form is known as *interstitial neuritis*, and is the condition usually found in the localized form. The nerve will be found to be swollen and red in color, but the nerve-fibers do not appear involved. Eventually, however, changes resembling those found in wallerian degeneration may occur, the myelin becoming fragmented, the nuclei in the sheath of Schwann increasing in number, the nuclei of the internodal cells becoming swollen, and the nerve-fibers undergoing granular degeneration. In *parenchymatous neuritis*, the condition found in multiple neuritis, the nerve-fibers are primarily and principally affected. Changes like those met with in wallerian degeneration described above are met with, but the sheath shows little evidence of inflammation.

Etiology.—(a) *Local neuritis* may be due to—(1) Exposure or cold (the so-called *rheumatic neuritis*). (2) Extension of inflammation from neighboring parts. (3) Traumatism—wounds, compression, excessive stretching resulting from fractures or dislocation, electric shock. (4) Microbic and autogenetic poisons. (5) Arteriosclerosis. (6) Stoop shoulders, which cause compression of the axillary structures between the humerus and ribs, causing either brachial or ulnar neuritis.

(b) *Multiple neuritis* may be due to—(1) Poisons of extrinsic origin—carbon monoxid, alcohol, carbon bisulphid, lead, arsenic, mercury, ether. (2) Poisons resulting from the infectious fevers (typhoid, diphtheria, variola, typhus, leprosy, beriberi, measles, syphilis, tuberculosis, septicemia, gonorrhea, malaria, influenza). (3) Poisons produced within the body, as from gout, rheumatism, diabetes, and pregnancy. (4) Cachexias, anemia, carcino-

cinations, delusions, disorientation, etc., a symptom group known as Korsakow's psychosis. The duration of an attack varies from a few weeks to a year or more.

Arsenic neuritis differs from the above in that the mental symptoms are generally absent. The onset may be much more abrupt and the course is usually shorter.

Carbon bisulphid neuritis occurs chiefly in workers in rubber factories and imitation silks. There are noted intense frontal headache, giddiness, marked excitability, muscular cramps, and possibly convulsions. *Saturnine neuritis* is confined to motor nerves, and especially to those of the upper extremities, the posterior interosseous branch of the musculospirals being especially liable to be involved, causing double wrist-drop. Any or all nerves may, however, become affected. Peculiar features are the usual absence of pain and tenderness, and the escape of the supinator longus and extensor ossis metacarpi pollicis muscles. Lesions of the anterior cornua are more likely to occur in saturnine multiple neuritis than in any of the other varieties. Delirium (lead encephalopathy), optic neuritis, and convulsions may occur, but are not common symptoms. Multiple neuritis is a frequent sequel of diphtheria; it is also rarely attended with pain and tenderness, and has been fully described on p. 157.

Cases due to other forms of infectious disease may be local or multiple, and generally present symptoms similar to those of neuritis due to any other cause. *Recurring Multiple Neuritis*.—A few cases have been reported in which attacks of more or less wide-spread paralysis, due to neuritis, have recurred. *Senile neuritis* occurs in old age, and is probably a degeneration due to arteriosclerosis. The symptoms develop gradually and consist of weakness and numbness of the limbs, especially the lower; absent knee-jerks, sometimes slight atrophy and diminished response to the faradic current. Cranial nerves may also be affected.

Multiple neuritis has followed the employment of the Pasteur treatment for rabies.

Spontaneous or the so-called *idiopathic neuritis* does not differ from the general type of the disease, except that no cause can be discovered to account for it.

Beriberi.—This is a form of multiple neuritis, occurring endemically, chiefly in the islands of the Pacific Ocean and in Asia. It is especially prevalent in Japan and the Philippines. Sporadic cases are met with in increasing frequency in Europe and America, brought on ships from the Orient. There is some dispute concerning its etiology, but the prevailing view is that it is due to the use of food in which the so-called vitamins are absent. This is notably so when the diet is one of "polished" rice. It is especially apt to occur where many are crowded into a limited space, as jails, barracks, ships, etc. Moisture and heat favor its development.

The essential feature of the pathology is the changes in the nerves; these are inflammatory and degenerative. Degeneration in the muscles also occurs, and not infrequently serous effusion. A variety of clinical types have been recognized. Of these, the most important are the wasting and the wet forms. The onset may be rapid or more gradual. In the first type there is loss of power in the limbs, wasting of the muscles, and more or less emaciation. Subjectively, there are pain and paresthesiæ in the limbs, tenderness in the muscles and over the nerve trunks. The patients also complain of weakness, dyspnea, and palpitation. The wet form is characterized by the earlier or later occurrence of general anasarca, with effusion into the serous cavities. The swelling may be enormous and obscure the muscular wasting. Sometimes the dyspnea

demanding in malaria, iodids and other measures to eliminate the lead in lead cases. As soon as the acute cases have subsided, massage and passive movements should be begun, galvanism applied to the muscles, and warm water or sulphur baths administered. Care should be taken to prevent stretching of paralyzed muscles and deformity due to the unopposed action of antagonistic muscles, as when foot- or wrist-drop is present.

PROGRESSIVE NEURAL MUSCULAR ATROPHY

(Hoffmann)

(*Progressive Neuritic Muscular Atrophy; Charcot-Marie-Tooth-Type of Progressive Muscular Atrophy; Peroneal Type, Gowers*)

Definition.—A degenerative process, apparently commencing in the nerves, and characterized by muscular degeneration, with subsequent contractures, sensory disturbances, and a loss of the reflexes.

Pathology.—The principal change is degeneration of the peripheral nerve-fibers; with this may be associated sclerosis of the posterior columns of the cord, slight degeneration of the pyramidal tracts, alteration of the columns of Clarke, atrophy of the cells in the anterior horns of the cord, atrophy of the muscle-fibers.

Etiology.—Heredity seems to play an important part in the causation of the disease, which may either occur in successive generations of a family or affect several members of the same generation. Sporadic cases occasionally occur for which it is impossible to trace any ancestral influence, though, as the disease has been known to skip a generation, it is not impossible that such cases are still hereditary. Males are much more frequently affected than females, and the disease almost invariably commences between the ages of ten and twenty years.

Symptoms.—As the name implies, muscular wasting usually begins in the muscles of the feet or hands, either the peronei, the common extensors of the toes, or the small muscles of the foot itself, or else in the muscles of the thenar and hypothenar eminences and the interossei. Usually the atrophy is symmetric. In the feet it leads to an early development of club-foot, which is most pronounced when the extremity is at rest. Very early the atrophy of the small muscles causes the toes to assume the claw position, and the atrophy of the peroneals causes foot-drop, so that in walking the foot is dragged along the ground. In the later stages the foot becomes permanently fixed in a position of equino-varus or valgus. The hands have the characteristic appearance given by a flattening of the ball of the thumb and middle finger. The interosseal grooves also become deeper and the fingers gradually assume the claw-like position (*main en griffe*). The disease extends slowly upward, involving the muscles of the calf and forearm; the muscles of the thighs, upper arms, and trunk usually escape. The affected muscles usually show distinct fibrillary twitchings. When electrically examined, the muscles either show a marked diminution in reaction to the galvanic and faradic currents, or distinct reaction of degeneration can be elicited. Similar electric changes are also found in the nerves. Mechanical excitability of the muscles is considerably diminished, these changes being found also in the muscles that are apparently healthy. The tendon reflexes are usually absent, although in the early stages, when the muscles of the thigh are still unaltered, the knee-jerk may be merely diminished. Sensation is sometimes unaltered, but ordinarily there is some diminution of sensibility in the peripheral parts of the limbs. Often there are paresthesiæ

Symptoms.—There may be none. When present their character necessarily depends on the nature of the nerve involved and whether the lesion is an irritative or destructive one. More or less pain, numbness or tingling, paresthesia, and palsy are among the most common. The tumors can usually be felt by palpation.

Treatment.—Apart from anodynes, operative measures alone are of value, except when the tumors are the result of syphilis, as occasionally happens; in such cases specific treatment must be employed.

It must not be forgotten, however, that stump neuromata may occur in those hereditarily predisposed, in which case, as Bowlby has pointed out, their removal will almost surely be followed by a return.

DISEASES OF THE CRANIAL NERVES

OLFACTORY NERVE

The following morbid conditions have been described in connection with the sense of smell:

(a) *Hyperosmia or Olfactory Hyperesthesia.*—The sense of smell is abnormally acute, so that objects, and even persons, can be recognized by this means. It occurs in hysteria and insanity.

(b) *Parosmia* (perverted sense of smell) may occur for one or for many odors, and is often associated with an obtunding of the normal sense.

(c) *Subjective sensations* of smell are due to the same causes as the above. An olfactory aura may precede an attack of epilepsy. Olfactory hallucinations occur occasionally in the insane, and in irritative lesions of the uncinate gyrus (Fig. 68).

(d) *Anosmia or olfactory anesthesia* (loss of the sense of smell) may be caused by—(1) Injury to the peripheral filament by local disease of the nasal mucous membrane. (2) Injury to the nerve-trunk or bulb, by blows on the head, basal fractures of the skull, bone disease, and meningitis. Anosmia may occur during locomotor ataxia. Pungent and powerful odors have been said to cause loss of the sense of smell, due to excessive stimulation. There may be a congenital absence of the olfactory nerves. (3) Centric lesions, as tumors in the region of the uncinate gyrus (Fig. 68). Unilateral anosmia has been described as part of a hemianesthesia, due to a lesion in the posterior part of the internal capsule and in hysteria.

In testing the sense of smell it is advisable to use aromatic oils, as they only stimulate the olfactory nerve, while ammonia and such strong substances also stimulate the fifth nerve. It is obviously necessary to make a rhinoscopic examination.

Treatment is generally unsatisfactory, though the cause must be removed when possible. When the disturbance is due to some general condition, as hysteria, it may, of course, be disregarded, as it will improve with the disease.

DISEASES OF THE RETINA, OPTIC NERVE, AND TRACT

The Retina.—Hemorrhage into the retina may be venous or arterial, single or multiple, monocular or binocular. It may be part of a general vascular change; occasionally it occurs during parturition, but more often at the menopause; it may be an indication of renal trouble or of some primary or symptomatic anemia, as in leukocythemia, pernicious anemia, or malaria. Hemor-

retrobulbar neuritis, see Toxic Amblyopia), and, second, where the lesions are visible at the intra-ocular nerve-ending. The latter is the more important, and is also known as papillitis. Optic neuritis may be caused by the acute infectious diseases, syphilis, lead, alcohol, uremia, anemia, menstrual disorders, exposure to cold, rheumatism, injuries, disease of the orbital region, and intranasal and accessory sinus lesions. Rarely it is congenital, and mild forms may be caused by refractive errors. When the nerve head projects markedly into the interior of the eye, it is known as "choked disk," or from the condition present, papilledema. This is not a true neuritis, but is due to mechanical causes. The early injection with stasis of the retinal vessels, edema, and elevation of the nerve-head, and final cellular infiltration, with new tissue formation leading to atrophy, are due to distention of the sheath of Schwabe by obstructed cerebrospinal fluid. Neuritis at times may be associated. Kidney disease may cause a similar condition. Intracranial lesions are the most frequent causes. Of these, brain tumor ranks first. Others are meningitis, cerebral abscess, cerebral and meningeal hemorrhage, thrombosis of the cavernous sinus, chronic hydrocephalus, serous meningitis, and aneurysm of the internal carotid. Vision may not be lost for some time. If the process is not arrested, consecutive atrophy occurs.

(2) *Optic Atrophy*.—This may be *primary*, when it is usually associated with disease of the spinal cord and brain, as tabes dorsalis, parietic dementia, and multiple sclerosis, *secondary*, when it results from pressure more or less directly applied to the optic chiasm or tracts, and *consecutive*, when it follows a previous neuritis or "choked disk." There is also an hereditary form known as Leber's disease, and that which occurs in amaurotic family idiocy (p. 1196).

In any case there is contraction of the field of vision and colors are not perceived in the normal order, *i. e.*, blue, red, green, but are reversed in various ways (dyschromatopsia). This also occurs in functional disorders, as hysteria. There is more or less dimness of sight. In the hereditary form the disk is less white than in the other, and the vessels are almost normal in appearance.

The Optic Tract.—The lesions of the optic tract may cause either blindness, dimness of vision, or *hemianopsia*. By the latter is meant blindness of one-half the visual field. As the light rays cross, the blind field is opposite to the blind half of the retina. Thus, if the nasal half of the retina is not functioning, the temporal field will be blind. It is always due to a lesion at or posterior to the chiasm. When the latter is the case, blindness in the temporal field of one side and nasal field of the other is caused. This is termed *homonymous lateral hemianopsia*. The blind fields are in the side opposite the lesion (Fig. 78). Lesions of the chiasm usually affect the decussating fibers, causing blindness of the nasal halves of the retina, and, in consequence, temporal hemianopsia. This condition occurs in basal tumors, especially of the hypophysis, and has also been observed in acromegaly, in tuberculous basal meningitis, and in hydrocephalus. When homonymous hemianopsia exists, to determine if the lesion is located in or anterior to the corpora quadrigemina, a very valuable sign, that, however, cannot always be elicited, is the failure of the pupil to contract when light is thrown upon the blind half of the retina. This is termed *Wernicke's hemianopic pupillary inaction* sign and is explained by the fact that the pupillary reflex center is situated in the anterior corpus quadrigeminus, lateral geniculate body, and pulvinar, which are termed the primary optic centers. If the lesions affect the optic thalamus or the internal capsule, hemiplegia and hemianesthesia are also often present or may form the most

important symptoms. Lesions posterior to the anterior corpora quadrigemina produce hemianopsia without disturbance of the pupillary reflex. These lesions are divided into two groups, the cortical and the subcortical, and they may be of two varieties, either irritative or paralytic. The irritative lesions give rise to hallucinations of sight, which may vary from the scotomata of migraine to most complex visions and may indicate tumor in the cuneus (Fig. 68). Occasionally curious symptoms are produced, the visual field being sometimes irregular, while at others only certain elements of sight are affected, cases having been reported in which the hemianopsia only involved the recognition of colors, not of form. In all these cases the pupillary reflexes are not affected. Bilateral lesions do not always lead to total blindness; sometimes the macula lutea escapes and the patient is able to see only by direct fixation. Cortical lesions are those involving the occipital lobe. The center of visual perception appears to be in the cuneus and calcarine fissure; if this is destroyed on both sides, blindness occurs. If on one side, lateral homonymous hemianopsia (Fig. 78). The center for the recognition of the object seen is apparently upon the convex surface of the occipital lobe, probably in the second and third convolutions, but it may extend also into the temporal lobe. When this is destroyed the patient can see either objects, words, letters, or symbols, as the case may be, with which he was once familiar, but fails to recognize them; this is called *mind-blindness* or visual agnosia (see p. 1026). Hemianopsia is very frequently merely a temporary symptom, and as such it may occur in uremia, apoplexy, migraine, and certain intoxications, especially that of lead. It may also occur in brain tumor, and disappear if the pressure is relieved, as by trephining. It is a permanent symptom only when the visual tract has been involved by some destructive lesion. If the patient is perfectly conscious and intelligent, it is not difficult to recognize it; nevertheless, its presence can often be detected in young children and in those who are only partially conscious or unable to speak. This can be accomplished by taking a bright object, placing it behind the head, and then bringing it forward slowly, first on one side and then on the other. It will then be noted that the patient perceives it on the hemianopsic side only, when it has been brought to the middle line, while when moved on the other side the eyes will turn toward it when it is still a considerable distance from this point. Another method is to bring a blunt object (a wisp of cotton) very nearly in contact with the cornea, first on the one and then on the other side of the median line. The palpebral reflex will occur upon the normal side while the object is still some distance away; on the blind side only when it has come in contact with the conjunctiva.

DISEASES OF THE MOTOR NERVES OF THE EYEBALL (THIRD, FOURTH, AND SIXTH)

The extrinsic ocular muscles are supplied by these three nerves, while the intrinsic are supplied by the third and the sympathetic.

I. The **motor oculi**, or **third nerve**, is purely motor, and supplies all the muscles of the eye except the superior oblique and external rectus, and controls in part also the ciliary muscle and the sphincter of the iris. Its apparent origin is from the inner side of the crus cerebri just anterior to the pons. It can be traced through the crus, however, to its deep origin in a nucleus beneath the corpora quadrigemina, situated in the floor of the aqueduct of Sylvius. Above the crus it pierces the dura, passes between the two clinoid processes of the sphenoid bone, along the outer wall of the cavernous sinus, where it receives some filaments from the cavernous plexus of the sympathetic; it then divides into two branches that enter the orbit through the sphenoid fissure. The superior and smaller division supplies the superior rectus and

glass. Bilateral cycloplegia is often due to a nuclear lesion. It occurs most frequently as a symptom of neuritis following diphtheria.

(b) **Iridoplegia.**—The pupil may be dilated (*mydriasis*) from palsy of the sphincter or spasm of the dilator, or it may be contracted (*myosis*) from the antithesis of the above.

The iris has three actions—two reflex and one associated: First, a reflex contraction of the sphincter on exposure of the eye to the light; second, a reflex dilatation of the radiating fibers on stimulation of some cutaneous nerve; and, third, a contraction on accommodation, usually, but not necessarily, associated with convergence (Gowers).

First, light-reflex iridoplegia. The iris reflex is lost in locomotor ataxia, in general paresis, and occasionally in disease of the peripheral portion of the third nerve, and sometimes also in syphilis. Accommodation and convergence are, however, usually preserved (*Argyll Robertson pupil*). When these also are lost the condition is termed *ophthalmoplegia interna* (see p. 1057).

In testing this reflex care must be taken to avoid the contraction of accommodation. The patient should look at a remote part of the room; then a light is brought suddenly in front of and 3 or 4 feet distant from the eye. One eye should be examined at a time, the other being covered, but not closed.

Second, skin-reflex iridoplegia. Normally, painful stimulation of the skin of the neck causes reflex dilatation of the pupil (pupillary skin-reflex), the afferent impulse being carried along the sympathetic. In locomotor ataxia myosis often exists. In such cases Erb showed that the skin-reflex was lost (*spinal myosis*).

Third, accommodation iridoplegia, in which the power of accommodation is lost. The pupil does not become smaller when looking at near objects. Westphal and Piltz have recently discovered independently that in certain pathologic conditions the pupil contracts strongly upon closure or attempted closure against resistance of the eyelids. This reflex occurs most constantly in general paresis. Its exact significance is not known.

II. The **fourth nerve, or patheticus**, the smallest cranial nerve, supplies the superior oblique muscle. Its superficial origin is to the outer side of the crus cerebri, just in front of the pons. The fibers can be traced backward to the valve of Vieussens, in the substance of which it decussates with its fellow. Its deep origin is in a nucleus in the floor of the aqueduct of Sylvius, immediately behind and in close connection with the third-nerve nucleus. After piercing the dura mater the nerve runs along the outer wall of the cavernous sinus and enters the orbit through the sphenoid fissure. Since the superior oblique muscle directs the eyeball downward and rotates it, paralysis causes defective downward and inward movements, and consequent diplopia with inclination of the head forward and to the sound side. When occurring alone it is probably due to a nuclear lesion.

III. The **sixth nerve, or abducens**, has its deep origin in the floor of the fourth ventricle in close proximity to the seventh-nerve nucleus. Its superficial origin is from the lower part of the pons, in the groove between it and the medulla. Emerging, it pierces the dura, runs along the cavernous sinus, and enters the orbit through the sphenoid fissure to supply the external rectus. Owing to its long course, this nerve is specially liable to injury, usually from pressure due to tumors or from syphilitic or other forms of meningitis. Its paralysis has been observed in connection with otitis media (Gradenigo's syndrome¹). Paralysis of the muscle causes convergent strabismus and consequent diplopia, owing to an inability to rotate the eye outward. If the nucleus is involved there will be loss of associated lateral movement of the eyes to the side of the lesion (that of the sixth-nerve palsy). This is due to the fact

¹ *Amer. Jour. Med. Sci.*, February, 1920, p. 227.

Gowers' mnemonic is, "When the visual lines (prolonged ocular axes) cross, the diplopia is not crossed."

Ophthalmoplegia, a paralytic condition of the eye muscles, may be partial or complete. Either the internal or the external muscles may be involved, constituting *ophthalmoplegia interna* or *externa*, and, when both are affected, total ophthalmoplegia. The lesion may be due to disease either of the nerve trunks or nuclei. The former may be due to some infectious disease, as diphtheria; excessive use of alcohol, arteriosclerosis; traumatism, causing either fracture at the base of the skull or hemorrhage into the region of the nerves; pressure of an aneurysm of a cerebral blood-vessel, basal meningitis, especially if syphilitic, and tumor. The latter may also be due to infectious diseases and excessive use of alcohol. Chronic lead-poisoning may also cause it, and it may be an early manifestation of either tabes, paresis, disseminated sclerosis, or cerebral syphilis. Tumors, inflammation within the orbit, or fractures involving it, and thrombosis of the cavernous sinus may also be causes of a more or less complete ophthalmoplegia. If acute, the condition may be due to a hemorrhage in the region of the nuclei, or an embolus or thrombosis in a branch of the basilar artery, or an inflammation of the nuclei, due either to infection or intoxication, as mentioned above (polio-encephalitis superior of Wernicke). Symptoms of bulbar palsy may coexist in chronic nuclear degenerations.

The **symptoms** vary necessarily according to the muscles involved. The eyes fail to follow objects and the face acquires a peculiar expression ("Hutchinson face").

The **treatment** consists in the removal of the cause when possible. When known to be due to syphilis, either arsphenamine or neo-arsphenamine should be administered, and repeated at intervals of a week or two until at least six injections have been given or the Wassermann reaction in the cerebrospinal fluid is negative. Mercury and the iodids must be given in the intervals and for some time after the last injection. It is well to use the latter in any case in which the etiology is doubtful. In inflammatory cases counterirritation is employed by blisters placed on the temples, behind the ears or at the occiput, or by leeches. Internally, the salicylates, mercury, iodids, and general tonics are useful. Rarely a case will recover spontaneously. Electricity is probably of little value. The diplopia, unless it can be obviated by a suitable lens, should be met by means of an opaque glass placed over one eye.

DISEASES OF THE FIFTH NERVE

The trigeminus nerve has an extensive origin from the floor of the fourth ventricle. It supplies with sensation the whole region innervated by all the other cranial nerves except the first and second. It resembles a spinal nerve in that it has two roots, a motor and sensory, and on the latter a ganglion (*gasserian*). From the latter arise three sensory branches—viz., the ophthalmic, superior maxillary, and inferior maxillary. A motor root joins the last named, the largest branch of the fifth nerve.

Morbid conditions of the fifth nerve cause sensory, motor, or gustatory symptoms. The lesion may be: (1) Pontine hemorrhage, softening, sclerosis, or tumor. (2) Disease or injury at the base of the brain—*e. g.*, meningitis, gumma or other tumor, caries of bone. (3) Disease or injury of the branches, as neuritis, pressure due to aneurysm of the internal carotid or to a tumor in the cerebellopontile angle or sphenomaxillary region, orbital cellulitis, and punctured wounds of the mouth and nose. (4) Rarely fracture of the skull. (5) Diseases of the gasserian ganglion.

Symptoms.—Sensory Portion.—In the irritative stage the chief feature is pain; this may be shooting, boring, or burning in character. Tender-

Treatment.—The underlying cause should be attacked when possible. Salvarsan, mercury, and the iodids should be administered in specific cases and the salicylates in those due to exposure. Analgesics, and even opiates, may be necessary. Sometimes vigorous counterirritation is of value. Attention must be paid to the condition of the general system.

DISEASES OF THE SEVENTH OR FACIAL NERVE

The nucleus of this nerve in the floor of the fourth ventricle is in relation with those of the sixth, eighth, and twelfth nerves. Like the spinal nerves, it has an upper and a lower neuron or motor segment, the former extending from the cortical center in the lower Rolandic region to the nucleus, while the latter runs from the nucleus to the periphery. Lesions may involve any part of the tract, producing either spasm or paralysis.

Spasm.—This may be either general or partial, affecting only the orbicularis palpebrarum (*blepharospasm*). It is sometimes called *tic facialis* or mimic spasm (p. 1167).

Etiology.—The commonest causes are peripheral irritations, and particularly those that involve the trigeminus, as carious teeth, conjunctivitis, or some nasal irritation. Less frequently irritation in some other part of the body, as intestinal parasites or uterine disease, may be the exciting cause. Finally, there may be lesions in any part of the motor tract supplying the face, either in the cortex (meningeal tumor, exostoses, or focal softening), when it becomes one of the manifestations of the jacksonian convulsion; in the facial nucleus in the lower part of the pons; along the course of the facial nerve (aneurysm or atheroma of the vertebral artery, tumor in the cerebellopontile angle); and as a sequel of peripheral paralysis of the nerve (Bell's palsy). Morbid changes in the nerve itself or in the muscles have not been observed.

The **symptoms** of the disease include, first, the *spasm*: this is usually a sudden clonic convulsion of the muscles of one side of the face, with closure of the eyelids and retraction of the angle of the mouth. Rarely there are associated movements of the palate and eyeballs. The spasms may be single or they may occur in groups frequently repeated, or recur constantly at more or less irregular intervals. Less frequently the contraction may be tonic in character, lasting several seconds or even minutes. These forms are frequently associated with clonic spasms. Ordinarily the spasm is painless. Sometimes there is also *tinnitus aurium*. Occasionally edema of the face, especially in the orbital region, occurs. The immediate exciting cause of an attack may be fatigue or excitement, or it may occur as an associated movement, as in a case that I observed, in which spasm always accompanied the beginning of speaking.

The **diagnosis** must be made from tic (p. 1168). It may be occasionally confounded with *chorea*, especially when the latter is chiefly localized in the face, or with *athetosis* due to infantile brain lesions. In the former the movements are not so quick nor confined exclusively to the anatomic distribution of a certain nerve; in the latter hemiplegia will usually coexist (p. 1123). In fact, athetosis is a spasm. Recognition of the cause is often very difficult, and a careful examination of the whole body should be made for any possible source of irritation.

The **prognosis** is extremely unfavorable for cure, since only in cases of recent occurrence, and with a distinct source of peripheral irritation, is permanent recovery likely.

The **treatment** consists in the removal of any source of irritation and the application of electricity, particularly the mild galvanic currents, with the

Symptoms.—The affected side is immobile and expressionless, and the normal lines are diminished or abolished. This is seen most markedly in those above middle life. The eye cannot be closed, owing to weakness of the orbicularis palpebrarum, and, as the tears are not directed into their proper channel, the eye waters. Voluntary and emotional movements are lost. Whistling and smoking are performed with difficulty, if at all; if the cheeks are puffed out, air escapes upon the paralyzed side; food collects between the teeth and cheek, owing to paralysis of the buccinator; in drinking the patient inclines the head to the sound side to prevent escape of the liquid from the corner of the mouth. The dilator naris is paralyzed; hence sniffing is interfered with, and the sense of smell is diminished on that side.

When the tongue is protruded it seems to be drawn toward the palsied side. This is not the case, however, the effect being due to contraction of the unopposed muscles on the sound side of the face. All reflex movements are lost. The palate is not affected and sensation is not impaired. When the nerve is involved between the *intumescencia gangliiformis* and the origin of the chorda tympani—*i. e.*, within the facial canal—taste is lost in the anterior part of the tongue, and there is some diminution in the secretion of saliva. When other parts of the nerve are diseased, taste is not interfered with. Hearing may be increased, owing to paralysis of the stapedius, with consequent unopposed action of the tensor tympani. When due to middle-ear disease and in disease of the base of the brain, involving both facial and auditory nerves, hearing is lessened. In the latter, however, bone conduction will be either diminished or lost. Some degree of wasting takes place in the affected muscles, and both quantitative and qualitative electric changes quickly follow the palsy. If the *intumescencia gangliiformis* is involved, we may have herpes of the auricle and neuralgic pains in the ear in addition to paralysis. This may also occur without paralysis.

The duration of an attack varies from a few days to several months or a year, and in rare cases it is permanent. The onset is usually acute, and the acme of the attack may be reached in from a few hours to a couple of days.

Diagnosis.—From the table previously given it will be easy to differentiate supranuclear from infranuclear palsy. When contractures have taken place, owing to the furrows thus produced the affected side may be taken for the sound side, but on getting the patient to whistle the true state of affairs will manifest itself.

Prognosis.—In the rheumatic cases and those due to middle-ear disease recovery usually occurs in from six weeks to three months. Permanent contractures and deformity sometimes associated with clonic spasm may result.

Treatment.—Search for the cause. If ear disease is present, make provision for free drainage; if syphilis, give salvarsan, with iodid of potash, and mercury. In cases due to cold, the so-called rheumatic palsies, counterirritation is especially called for, and cantharidal collodion, fly-blisters, or the actual cautery behind the ear or over the occiput are very useful. The bowels should be freely opened, and diaphoretics or hot baths, alkaline diuretics, and salicylates administered; in the inflammatory stage small doses of mercury are of value, and later mercuric iodid or general tonics. After the acute symptoms have subsided (in about ten days), galvanism should be employed to stimulate the nerves and to help in maintaining the tone of the muscles. When contractures threaten in the late cases the use of electricity should be dispensed with. When the paralysis has become permanent, benefit can sometimes be rendered by transplanting parts of either the hypoglossal or spinal accessory motor nerves into the trunk of the facial peripheral to the lesion.

are involved. For tinnitus, counterirritation and electricity may be tried externally, and iodids internally, but with little hope of relief; in addition, sedatives, as the bromids, are generally called for, and even morphin may be necessary in paroxysmal attacks. Occasionally a single large dose of pilocarpin (gr. $\frac{1}{16}$) may give relief for some time. Operation has been resorted to (p. 1065).

(d) *Vertigo* or *dizziness*, is due to disease or disturbance of either the internal ear or its intracranial pathways. According to Jones and Fisher¹ these are as follows: The fibers from the horizontal semicircular canals pass through the eighth nerve, enter the brain stem at the junction of the medulla and pons, and run to Deiter's nucleus. There they divide into two pathways, one of which passes through the posterior longitudinal bundle in the pons to the nuclei of the eye muscles. It is concerned in the production of nystagmus and is known as the vestibulo-ocular tract (p. 1054). The other, known as the vestibulocerebellocerebral tract, is responsible for vertigo. Its course is from Deiter's nucleus, through the inferior cerebellar peduncle, to the cerebellum (three vestibular cerebellar nuclei). From here it passes upward through the superior cerebellar peduncle, crus, and thence to the cerebral cortex of both sides, but principally the opposite. The cortical center is believed by Mills to be in the posterior portion of the second temporal convolution. This center is connected with other parts of the cortex, especially the frontal lobe.

From the vertical semicircular canal the fibers, after passing through the eighth nerve, ascend in the pons to a point above its middle, where, at an undetermined cell nest, they divide into two pathways, one of which becomes part of the vestibulo-ocular tract and the other (vestibulocerebellocerebral tract) passes through the middle cerebellar peduncles to the cerebellar nuclei above mentioned of the same side. From here their course is similar to those from the horizontal canal.

Disturbances of this apparatus may be due to a number of causes, either functional or organic..

1. *Visual defects*, as loss of muscle balance or eye-strain.
2. *Disease of either the middle or internal ear* (p. 1064).
3. *Organic disease of the brain*, especially if any part of the tracts above mentioned is involved.
4. *Toxemia*, as alcohol, tobacco, quinin, salicylic acid, auto-intoxication from constipation, etc.
5. *Derangement of the cerebral circulation*, as in anemia, cardiac weakness, and arteriosclerosis.
6. *Neuroses*, as neurasthenia and hysteria.
7. *Obstruction of the nasal passages and sinuses*.
8. *Acute vertigo* may be due to swinging, sea-sickness, rapid rotation of the body, looking down from great heights, blows on the head, and passing an electric current through it.
9. A *hereditary form* has been described.

Vertigo may be *subjective*, in which the patient feels as if he were whirling about, and *objective*, in which objects seem to move about the patient.

It is frequently accompanied by nystagmus (p. 1054), mental confusion, pallor, and nausea and vomiting.

To determine if the vertigo depends upon organic disease and also its location the turning, caloric, and pointing tests of Bárány are used. These depend upon the facts that in a normal person either whirling the patient about or syringing the external ear with water of certain temperatures causes nystagmus and vertigo. If the lesion is a distinctive one of the internal ear or eighth nerve

¹ *Pennsylvania Med. Jour.*, December, 1916, pp. 174-178.

Prognosis.—In some cases the condition grows progressively worse until deafness supervenes, when it ceases. Often, however, arrest or improvement, or even complete recovery, may be secured. In heart disease the shock may prove fatal, and in the very acute but, fortunately, rare cases the prognosis is always bad.

Treatment.—Counterirritation over the mastoid process and the internal use of bromids to lessen the morbid sensibility will prove valuable. The excretories must be gotten in good condition, and any underlying disease, as arteriosclerosis, syphilis, or gout, must be treated. Charcot suggested the use of drugs that produce tinnitus—quinin, for instance. The cases were worse at the time, but some of them seemed to improve subsequently. Gowers employs sodium salicylate in 5-gr. (0.324) doses, thrice daily, believing that more good arises when such drugs are given in moderation. Small doses of pilocarpin sometimes do good. Nitroglycerin and the nitrites are sometimes of value in cases associated with arteriosclerosis. Division of the auditory nerve has cured some cases.

DISEASES OF THE GLOSSOPHARYNGEAL NERVE

The ninth cranial nerve has its origin in the posterior part of the floor of the fourth ventricle, in close relation with the pneumogastric nerve. Our knowledge as to its function is not exact, both because it is seldom if ever involved alone, and also, on account of its many connections (with the trigeminal, the facial, the pneumogastric, and the sympathetic nerves), it is difficult to say whether the terminal fibers involved represent the functions of its roots or of one of its connections (Gowers).

Its fibers are distributed to the tonsils, the back of the tongue, the soft palate, the pharynx, the Eustachian tubes, the tympanic cavity. It supplies both motor and sensory fibers, it is also the nerve of taste, certainly for the posterior portion of the tongue, and possibly, by means of connections with the fifth nerve, for the anterior as well. This nerve is involved in the nuclear degenerations that are spoken of as bulbar palsies. It may also be affected by meningitis or new growths.

DISEASES OF THE PNEUMOGASTRIC NERVE

As already stated, the origin of the tenth cranial nerve is in intimate relation with that of the ninth. It is also continuous below with that of the eleventh, and all three are associated with the center for the hypoglossal nerve. The nerve proper arises from the side of the medulla, and runs on either side of the neck in the sheath of the carotid artery, lying behind that vessel. It enters the thorax in front of the subclavian artery on the right side, and between the subclavian and the carotid on the left; then it courses beside the esophagus, and is distributed to the pharynx, larynx, lungs, heart, esophagus, and stomach, and sends fibers to the intestines and spleen.

The esophageal fibers are both motor and sensory, gastric fibers being chiefly sensory. The vagus is in part the motor nerve of the intestines. It also contains both accelerator and inhibitory fibers for the respiratory center, is the cardiac inhibitory nerve and a vasodilator, and is said to contain trophic fibers for the heart and lungs.

Etiology.—The nerve may be involved at its nucleus either by hemorrhage or softening. The nuclei of the ninth, eleventh, and twelfth nerves, and frequently the seventh are simultaneously attacked, either wholly or in

disease of the lung or esophagus, intrathoracic, and thyroid tumors. The left is the more frequently involved.

A cerebral lesion in the laryngeal cortical center may cause pseudobulbar paralysis. Since the two centers are compensatory, the lesion must be bilateral. This may also be caused by capsular lesions (p. 1019).

The nerve may be involved at its root or in any part of the trunk. The peripheral filaments may be attacked as part of a multiple neuritis.

In certain cases the muscles become weakened without being paralyzed, this possibly being due to a local neuritis, or to a congestion and inflammation of the mucous membrane from overuse (*clergymen's sore throat*), or as the result of exposure.

The following are the chief forms of paralysis:

(1) *Complete Paralysis*.—By this is generally understood paralysis of all except the cricothyroid and epiglottidean muscles, though occasionally these may also be involved. Since the cords are paralyzed, phonation is impossible. As a rule, there is no interference with respiration, though the pressure of the in-going air may bring the cords nearer together, and thus produce a certain amount of inspiratory harshness.

As the cords cannot be closed, coughing is impossible, as the air escapes through the glottis, and no expulsive force can be given to it. When the paralysis is unilateral these symptoms will of necessity be modified, and some degree of phonation may be possible. The most common cause of this condition is an involvement of the recurrent laryngeal nerve; the lesion may, however, be nuclear or in the course of the nerve-trunk.

(2) *Paralysis of the Abductors*.—The only special abductor muscles are the posterior crico-arytenoids. When they are involved the glottis fails to open in inspiration, and the unopposed adductors bring the vocal cords together. They are still more closely approximated during inspiration by the column of air, and hence the prolonged, stridulous inspiratory sound. Phonation and expiration are practically unchanged. It is quite likely that many cases supposed to be instances of hysteric spasm of the glottis are really cases of abductor paralysis.

In unilateral paralysis the normal movements of the unaffected vocal cord prevent any marked degree of dyspnea and stridor: phonation is usually hoarse and of low pitch. In cases of long duration the symptoms become more marked as the unopposed adductors undergo secondary contracture and still further narrow the glottis.

This condition may be due either to central disease or to some local change. The abductor muscles may be degenerated, while all the other laryngeal muscles are healthy, or one or both recurrent nerves may be affected. These nerves innervate both the abductors and adductors, and it is not clearly understood why the abductors alone should suffer when the parent nerve-trunk is involved. At any time it might be a very grave condition, for should any swelling of the cords supervene nothing but a prompt laryngotomy could prevent suffocation.

(3) *Adductor Paralysis*.—The cords move normally during respiration, and hence there is no stridor; as they cannot be approximated, however, phonation is impossible. This condition is met with in hysteria, producing hysteric aphonia, in public speakers who overtax their voices, and also in laryngitis.

The table on page 1068, from Gowers' text-book on *Diseases of the Nervous System*, enables one to get a comprehensive idea of the subject.

SYMPTOMS	SIGNS	LESIONS
No voice; no cough; stridor only on deep inspiration.	Both cords moderately abducted and motionless.	Total bilateral palsy.
Voice low-pitched and hoarse; no cough; stridor absent or slight on deep breathing.	One cord moderately abducted and motionless, the other moving freely, and even beyond the middle line in phonation.	Total unilateral palsy.
Voice little changed; cough normal; inspiration difficult and long, with loud stridor.	Both cords near together, and, during inspiration, not separated, but even drawn nearer together.	Total abductor palsy.
Symptoms inconclusive; little affection of voice or cough.	One cord near the middle line, not moving during inspiration; the other normal.	Unilateral abductor palsy.
No voice; perfect cough; no stridor or dyspnea.	Cords normal in position, and moving normally in respiration, but not brought together on an attempt at phonation.	Adductor palsy.

Sensory disturbances of the larynx are rare, and especially hyperesthesia. Anesthesia may be due to hysteria, or to bulbar paralysis, or to disease of the superior laryngeal nerve. It is dangerous, as food may enter the windpipe.

(c) **Cardiac Branches.**—These with branches from the sympathetic form the cardiac plexus. The vagus contains both accelerator and inhibitory fibers, but the latter predominate; therefore irritation of the nerve, either centric or peripheral, will slow the heart's action. Czermak was able to slow the action of his heart by pressing a small tumor in his neck against the vagus nerve. When the function of the nerve is lowered, inhibition is removed and the heart's action becomes rapid. This may be brought about by a toxemic neuritis, by pressure, accidental ligature, or by incised or punctured wounds. Various emotions and nervous states may bring about the same result.

(d) **Pulmonary Branches.**—Both accelerator and inhibitory fibers exist, but in this case the accelerator influence predominates, so that irritation results in increased respiratory movements or even in bronchial spasm, since the bronchial muscles are also supplied by this nerve. It is this nerve that is supposed to be concerned in the production of asthmatic paroxysms. Therefore, when the nerve function is lowered the respirations become much slower. The nerve is supposed to contain trophic fibers for the lungs.

(e) **Esophageal**, (f) **Gastric**, and (g) **Intestinal Branches.**—The esophageal branches are rarely damaged, and irritation (spasm) occurs more frequently than paralysis. The pneumogastric gives the sensory, and in part the motor, nerve supply to the stomach, and irritation gives rise to increased contractions with some pain.

The sensation of hunger is supposed to be associated with the vagus nerve, and vomiting may result from direct or reflex irritation. Paralysis causes some diminution of the gastric contractions. Normally, the vagi accelerate intestinal peristalsis.

Treatment.—It is almost always impossible to remove the cause of the above conditions. Syphilitic lesions are probably the most amenable, and in the various laryngeal palsies electricity may be employed, though it is of somewhat doubtful utility, and in abductor palsy may possibly exert a harmful influence by stimulating the adductors. Strychnin and general tonics should be administered. Massage of the larynx may be tried, and in spasmodic conditions attention should be directed to the general physical state. All

sources of nerve irritation should be removed if possible, and bromids, or even chloral, should be given.

*Vagotony.*¹—This term has been applied to a neurosis in which there is hypertonicity or irritation of the nerves comprising the autonomic nervous system (p. 1015), but principally of the vagus nerve and evidence of increased innervation of the organs controlled by it. Symptoms referable to the gastrointestinal tract are most prominent and consist of a state of hypertonus in the musculature of the stomach and intestines causing principally spastic constipation, a tender palpable colon, a tightly contracted external sphincter, abdominal pain and tenderness which may be mistaken for either that of appendicitis, cholecystic, duodenal, or gastric lesions, depending whether the transverse colon or cecal region is affected. Pain may also be experienced in the region of the descending colon. It is usually more marked either just before or after defecation, and may be excited by cold drinks or rapid eating. Attacks of mucous diarrhea may occur at intervals. Hyperacidity of the stomach and pylorospasm, bronchial asthma, bradycardia and cardiac arrhythmia, increased perspiration and urination, facial flushing, cold extremities, contracted pupils, eosinophilia, hypersensitiveness to pilocarpin, and dermatographia are also symptoms that may occur. A confirmatory test, not always present, is dilatation of the pupils on forced inspiration and contraction on expiration; also the pulse may be likewise quickened or slowed. Smith² has called attention to the resemblance of the symptoms of anaphylaxis to those of vagotony, and states that it manifests itself chiefly through vagus irritation. The relation, therefore, of the symptoms of vagotony to certain articles of diet is important. Other causes may be ductless gland disturbances, principally hyperthyroidism and chronic bacterial infection, principally tuberculosis.

The sympathetic division of the vegetative nervous system may similarly be affected and produce symptoms the reverse of those mentioned as characteristic of vagotony. This complex has been termed *sympathicotony*. In addition to the symptoms the following tests may be used to differentiate the two, viz.: pilocarpin causes sweating and salivation in the former and none in the latter; dyspnea caused by vagotony is relieved by atropin, that caused by sympathicotony is not; in vagotonia there is increased carbohydrate tolerance, in sympathicotony it is diminished. Epinephrin given to one with sympathicotony causes tachycardia, increased blood-pressure, and exophthalmos.

For *vagotony* belladonna in some form in full doses is of great value. Constipation should be treated with either phenolphthalein, agar-agar, liquid vaselin, or olive oil. Enemata of olive oil may be useful. The diet should be carefully regulated.

DISEASES OF THE SPINAL ACCESSORY NERVE

This nerve consists of two parts—an external or spinal, and an internal or accessory, portion. The latter has already been described in connection with the pneumogastric nerve. It forms the motor portion of that nerve, and is distributed to the laryngeal and pharyngeal muscles. The spinal element arises from the multipolar ganglion cells in the anterior gray horns of the cervical cord, ascends and enters the cranium through the foramen magnum, and leaves it, after joining with the accessory part, through the jugular foramen. It supplies the sternomastoid muscle and in part the trapezius.

Injury or disease of the nerve may result in spasm or paralysis. Only the spinal part is considered in this section.

¹ Spitzig, *Jour. Amer. Med. Assoc.*, January 31, 1914, 364; Wolfsohn, *Ibid.*, May 16, 1914, p. 1335; Held and Gross, *Ibid.*, January 22, 1916, p. 233.

² *Jour. of Nerv. and Ment. Dis.*, January, 1917, p. 26.

TORTICOLLIS

(Wry-neck)

This may be a congenital or an acquired condition.

Congenital torticollis, or "fixed wry-neck," is the result of an atrophy and shortening of the sternomastoid muscle, brought about by some intra-uterine condition or, possibly, by an injury at birth. The right muscle is most commonly affected. The head turns slightly toward the sound side; the eye may deviate, and curvature of the cervical spine may develop.

Facial asymmetry is a usual concomitant of this condition. The face on the same side as the lesion develops less rapidly than the other side, and in time secondary contracture of the unopposed muscles takes place. The torticollis can be cured by tenotomy, but the facial asymmetry persists. Fixation is necessary for a while when contracture exists.

Spasmodic wry-neck may be tonic or clonic. These forms may coexist, alternate, or occur independently in different individuals. The condition is met with almost exclusively in adults, and occurs most frequently in middle-aged men.

Pathology.—Usually no macroscopic or microscopic evidence of any lesion has been discovered, and the condition is probably dependent upon an overactivity of the neurons in the various centers that control the muscles of the affected part. Some cases belong to the Tics (p. 1167).

Etiology.—The influence of sex and age has been mentioned; a neurotic heredity may also predispose. Torticollis may follow habit-spasm, or some injury to the head or neck, or exposure to cold, the latter constituting the "rheumatic" type. It may be due to an irritative lesion either in the spinal cord above the fifth cervical segment, or to tumor, hemorrhage, meningitis, or bone disease in the upper part of the vertebral canal. Most cases are apparently functional, and may be due to reflex irritation, as eye-strain, or occur without apparent cause.

Symptoms.—The occiput is drawn toward the shoulder of the affected side, the chin is elevated, and the face rotated more or less toward the sound side. The sternomastoid may alone be affected, but the upper fibers of the trapezius are usually also involved. In addition, the superior obliquus and complexus of the same side and the splenius capitis and inferior obliquus of the opposite may be involved. Affection of the deep muscles causes greater retraction of the head than when the sternomastoid and trapezius alone are the seat of spasm. Spinal curvature may ensue, the convexity being toward the sound side. This only takes place in cases that have existed for some time. Clonic spasm is infinitely more distressing and more apt to be permanent.

Some pain and muscular twitching may precede the onset of the attack, though, as a rule, muscular contractions are the first indication. These are mild at first, and rarely abruptly, more commonly slowly, they increase in severity. As the case progresses other muscles, and even those of the arm, become involved. Cases have been described in which certain muscles or groups of muscles in the hand or arm have been primarily affected, the condition gradually spreading from them. The spasm usually ceases during sleep. An attack may cause pain, but, as a rule, it induces merely a feeling of fatigue in the muscles; it is worse if the patient is excited or emotional. Bilateral spasm may occur, the muscles of both sides being equally affected (*retro-colic spasm*). Gowers speaks of a case in which the backward displacement of the head was so great that the face was horizontal and looked directly upward.

Diagnosis.—As a rule this is not difficult. When spasm is induced by enlarged and painful glands beneath the sternomastoid the age of the patient will be of value in determining the true condition. This usually occurs in children; true wry-neck, on the other hand, very rarely commences before the thirtieth year. Hysteric spasm may also simulate spasmodic torticollis, but it generally occurs in young women, and usually other evidences of hysteria are also present. The *rheumatic type* and the rigidity induced by *caries of the spine* must be differentiated from one another and from spasmodic wry-neck. If the rigidity comes on suddenly, following exposure to cold or wet, and the pain is not increased at night or by depressing the head upon the spine, and is relieved by hot applications, the condition is probably rheumatic. When the rigidity and pain are of slow onset, without history of exposure, and the pain is both worse at night and is increased by depressing the head upon the spine, but is relieved by elevating the head, the condition is very probably one of caries of the spine. If there is doubt, a skiagram will reveal the true condition. In irritative lesions within the spinal canal, either intra-, or extramedullary, the spasm is usually bilateral and tonic, and other symptoms of involvement of the cord are likely to be found.

Prognosis.—Very rarely the torticollis may diminish or even cease after an existence of months or years. Usually, however, it is persistent, either being stationary or slowly increasing in severity and widening in range. The prognosis must always be guarded, and in severe cases grave as to recovery, though the disease does not shorten life.

Treatment.—Generally very little can be expected from medication. Bromids, morphin, chloral, hyoscyamus, or cannabis indica may be tried, as may the various forms of counterirritation. Atropin, in increasing doses, administered hypodermically into the muscles, has been effectual in some cases. Massage of the affected muscles and rest in bed may also at times be of service. Galvanism should be tried, the negative pole being placed over the occipital region and the positive over the affected muscles. Nerve-stretching and tenotomy of the affected muscles is of very little value. The only surgical procedure that has proved of any distinct value is neurectomy of the spinal accessory and posterior branches of the upper four cervical nerves, with excision of a part of the nerves to prevent reunion. This necessarily causes paralysis and atrophy of the muscles supplied; but, since it often abolishes the spasm, the slight loss of power and the interference with the movement of the head are comparatively infinitesimal. The results, however, are not positive, even so far as the spasm is concerned.

PARALYSIS OF THE SPINAL ACCESSORY NERVE

The accessory portion has been previously considered in describing the laryngeal branches of the pneumogastric.

In the spinal portion the nuclei may be involved in degenerative lesions of the motor region of the spinal gray matter. The nerve-trunk may be damaged by pressure from exudative products (meningitis), tumors, or caries, with resulting paralysis and wasting of the sternomastoid and, in part, of the trapezius. This latter muscle is also supplied by the cervical nerves. The patient has difficulty in rotating the head to the side opposite that on which the paralysis exists, and the affected muscle does not stand out in movements of the head. Unless secondary contraction of the unopposed muscle sets in, no deviation occurs when the head is at rest. The only portion of the trapezius that is involved in paralysis of the external part of the eleventh nerve stretches from the occipital bone to the acromion. The normal contour of the neck is lost in such cases, and the ability to raise the arm is interfered with because the trape-

zius cannot fix the scapula, the fulcrum of the deltoid. Bilateral paralysis may occur as in progressive muscular atrophy; if both sternomastoids are involved, the head falls backward; if both trapezii, it falls forward.

The **treatment** is that of the underlying cause. If the lesion is nuclear, practically nothing can be done. If the condition is due to pressure, in some cases relief may be obtained. Electricity and massage should be employed during the recovery of the nerve.

DISEASES OF THE HYPOGLOSSAL NERVE

The nucleus of the twelfth cranial nerve is in the most posterior portion of the floor of the fourth ventricle. It is said by some observers that the nuclei of the fibers for the palate and vocal cords that run in the spinal accessory nerve may be in the lower part of the twelfth-nerve nucleus.

The cortical center for this nerve is in the lower part of the ascending frontal convolution, in the neighborhood of the cortical facial center. This propinquity probably explains the simultaneous involvement of the facial and lingual muscles in some cases. The hypoglossal is the motor nerve for the tongue and for most of the muscles attached to the hyoid bone. Spasm or paralysis may follow disease of the nerve.

Spasm may be either unilateral or bilateral. It is probably met with most commonly in hysteria, or as a part of some general convulsive condition, as epilepsy or chorea. It may also be associated with facial spasm, as mentioned above. Irritation of the fifth nerve (dental caries, ulceration of the gums) seems to be responsible for some cases. "Paroxysmal clonic spasm" is a form in which the tongue is rapidly thrust in and out (p. 1167). Various sensations in the affected region may precede the attack. A rare form—*aphthongia*—is induced when an attempt to speak is made. The prognosis in this condition is good, and a general tonic treatment is indicated.

Paralysis may result from supranuclear, nuclear, or intranuclear lesions.

Supranuclear.—The lesion may be anywhere between the cortex (lower part of the ascending frontal gyrus) and the medulla, and causes paralysis on the opposite side. In this condition the affected muscles do not atrophy nor do they show any electric change. If unilateral, the tongue when protruded deviates to the side of the lesion.

Nuclear.—The lesion is usually degenerative. It may either be of sudden onset (vascular), less rapid, but still acute (inflammatory), or it may be chronic, as in bulbar palsy or tabes dorsalis. The nuclei are so close together that the condition is almost invariably bilateral.

Infranuclear.—The fibers may be injured by the pressure of neoplasms or by the products of meningitis or of syphilis. Disease of the bone may also involve the nerve in its passage through the foramen. More rarely, some traumatism or disease of the upper cervical vertebræ may simultaneously injure the eleventh and twelfth nerves.

Symptoms.—Paralysis and atrophy of one or both sides of the tongue and fibrillary twitchings may be noted, and if the condition be unilateral, the tongue when protruded deviates toward the affected side. Articulation, mastication, and swallowing are but very slightly interfered with. In the bilateral form, however, these are very much impaired; the tongue cannot be protruded and lies motionless on the floor of the mouth. The atrophy is muscular. This throws the mucous membrane into deep folds. Sensation and taste are unaltered.

Diagnosis.—If the lesion is supranuclear, there is usually hemiplegia on the same side as the lingual paralysis, without atrophy of the tongue muscles. When nuclear it is, as has been said, generally bilateral and forms part

of a bulbar paralysis. There is also wasting of the lingual muscles. When the fibers are involved in the medulla there is paralysis of the tongue on one side, of the limbs on the other, and the tongue deviates from the paralyzed side of the body. Outside the medulla the condition is, as a rule, unilateral, and the spinal accessory fibers are frequently involved. In the nuclear and intranuclear varieties there is wasting of the muscles.

The **prognosis** is usually unfavorable, and the **treatment** consists of a course of general tonics and of mercury and the iodids, with counterirritation.

DISEASES OF THE SPINAL NERVES

DISEASES OF THE CERVICAL PLEXUS

The branches arising from the posterior divisions of the upper four cervical nerves may be the seat of pain (cervico-occipital neuralgia) (p. 1041),

Phrenic Nerve.—This nerve is usually involved as a result of some lesion of the ganglion cells in the anterior gray horns at the level of the third or fourth cervical segments. The trunk may be damaged by pressure, as by aneurysm or neoplasms, or by traumatism, or it may be the seat of neuritis. More or less immobility of the diaphragm follows, amounting in some cases to complete paralysis. This is not readily seen with the patient at rest, and in women it is specially hard to observe, as their breathing is chiefly of the costal type. The abdomen moves in during inspiration, and out during expiration, forming the reverse of the normal movements. Exertion readily causes dyspnea, and pulmonary diseases are apt to be exaggerated as the products of secretion accumulate. If the lesion is bilateral, death occurs in a very short time after distressing dyspnea. Neuritis of one phrenic nerve has been observed, and leads to high position of the diaphragm on the affected side, with collapse of the corresponding lung. The x-ray may assist in the diagnosis.

Irritation of this nerve causes the symptom known as *hiccup*, which may be due to various gastro-intestinal disturbances, neuroses, and in some cases seems to be idiopathic. It is often very rebellious to treatment. A stubborn functional form occurs in hysteria (see also p. 1180).

The treatment of chronic hiccup consists in the administration of nerve sedatives, as valerian, hyoscin hydrobromate, bromids, etc.; rest, electricity in the form either of the constant or faradic current, either placing one electrode (the anode if the former is used) on the neck back of the sternomastoid muscle and the other on the body in the region of the diaphragm, or placing them on each side of the body in this region. Injections of apomorphin (gr. $\frac{1}{4}$) have been recommended. In extreme cases morphin must be used.

DISEASES OF THE BRACHIAL PLEXUS

This may either be involved *in toto*, or any of its branches may be affected separately, or the nerve-roots that unite to form the brachial plexus. Isolated disease of any of the roots may be produced by injury, caries of the vertebræ, or meningeal disease. The symptoms will be almost exactly the same as those produced by disease of the corresponding segment of the cord, but are more likely to be unilateral, and to be either purely motor or sensory, unless the lesion is extensive.

The posterior thoracic supplies the serratus magnus muscle. It may be injured directly by pressure, as in the carrying of heavy loads on the shoulder or

supinators. Probably the point most commonly attacked is about the middle of the humerus. In such cases the triceps escapes. The characteristic symptoms, however, are wrist-drop and finger-drop, consisting of an inability to extend the hand on the forearm, also the first phalanges of the fingers and thumb. In pressure palsies, usually due to sleeping with the head upon the arm, particularly after the excessive use of alcohol, the power of supination is usually lost also. Sensory symptoms vary and are seldom pronounced. There may be slight impairment or tingling or burning sensations.

This condition can usually be differentiated from lead-palsy by the rapidity of onset—by the fact that pressure palsies are almost invariably unilateral, and that the supinators are involved. Lead-palsy has a slow onset and is bilateral, generally without supinator involvement. Loss of sensation precedes the pressure palsy. The history too will generally throw some light on the case. I have seen a case of right-sided unilateral wrist-drop in a man who worked in lead with his right hand only. Bilateral wrist-drop may occur in any form of toxic neuritis, but the involvement of other nerves, the manner of attack, and the history of the case will serve to simplify the diagnosis.

Recovery follows in almost all cases of musculospiral nerve involvement, though in cases in which qualitative nerve changes have taken place it is necessarily delayed.

The *treatment* is that of neuritis.

The *median nerve* supplies the pronators, digital flexors, except the ulnar half of the deep flexor, the radial flexor of the wrist, the abductor and flexor muscles of the thumb, and the two radial lumbricales. It furnishes sensation to the radial side of the palm and front of the thumb, and to the front and back of the first and second and half of the third fingers. This nerve may be the seat of an injury or of neuritis, but is seldom involved alone. A form described by Hunt is due to pressure upon the nerve at the base of the thenar eminence, the principal symptoms being atrophy and paralysis of the muscles forming it. Localization in this group distinguishes it from a beginning progressive muscular atrophy (p. 1104). The most striking symptoms of median nerve palsy are wasting of the thenar eminence, an inability to oppose the thumb to the tips of the fingers, and loss of pronation of the forearm. Ulnar flexion of the wrist alone remains. Flexion of the second phalanges upon the first is interfered with. Sensation may or may not be lost. Pain and trophic ulcerations are often pronounced.

The *ulnar nerve* supplies the ulnar flexor of the wrist, the ulnar half of the deep flexor of the fingers, the muscles of the little finger, the adductor and inner head of the shorter flexor of the thumb, the interossei, and some of the lumbricales. It supplies with sensation the front of one and a half and the back of two and a half fingers on the ulnar side. Paralysis causes radial deviation of the hand in flexion of the wrist, loss of adduction of the thumb, and inability to move the little finger. The hypothenar prominence disappears.

The first phalanges cannot be flexed, and the second and third cannot be extended. This is exaggerated in old cases, though still it is not so marked as the "claw hand" of progressive muscular atrophy, since the first two lumbricales escape, being supplied by the median nerve. Sensory symptoms vary. If the deep palmar branch alone is affected, as it may be by pressure, as it passes between the tendinous origins of the abductor minimi digiti and flexor brevis minimi digiti, the sensory symptoms are absent. Care must be taken not to mistake this condition for the beginning of a progressive spinal muscular atrophy (p. 1104).

The *diagnosis* is usually easy. It is well to remember that, since this nerve

is the lowest in its point of origin of any considered in this group, ascending cord diseases will involve it before any of the other brachial nerves. It may also be damaged by disease limited to the lowest part of the cervical enlargement of the cord.

DISEASES OF THE LUMBAR AND SACRAL PLEXUSES

The **lumbar plexus or its branches** may be involved by abdominal growths, enlarged glands, psoas abscess, disease of the vertebræ, neuritis, and rarely by wounds or dislocation of the hip or during parturition.

The Obturator Nerve.—When the power of adduction of the thigh is lost and the affected leg cannot be crossed over the other, outward rotation is somewhat impaired.

Anterior crural nerve paralysis causes loss of power and wasting of the extensors of the knee, loss of knee-jerk, and anesthesia of most of the thigh and the inner side of the leg and foot.

The *superior gluteal nerve* supplies the gluteus minimus and medius muscles. When it is involved adduction and circumduction of the thigh are lost.

The **sacral plexus and its branches** may be damaged by pelvic neoplasms or inflammation, neuritis (generally secondary to sciatic nerve involvement), pressure during labor, wounds, dislocations, aneurysms, and diseases of the bone.

The *small sciatic nerve* supplies the gluteus maximus muscle. It is seldom involved alone. Lesions cause difficulty in rising from the sitting posture and anesthesia of the back of the thigh and of the upper part of the leg posteriorly.

The *great sciatic nerve* supplies the flexors of the leg and the muscles below the knee, and also sensation to the outer half of the leg, the sole, and part of the dorsum of the foot. Paralysis causes more or less interference with the act of walking, anesthesia in the part supplied, and wasting of the muscles. More or less weakness of them may sometimes be discovered in sciatica. (See Sciatica, p. 1042).

The *external popliteal or peroneal nerve* supplies the tibialis anticus, the peronei, the long extensor of the toes, and the extensor brevis digitorum; it also supplies sensation to the outer half of the front of the leg and to the dorsum of the foot. Paralysis causes foot-drop and toe-drop, rendering it necessary to lift the leg high in walking, so that the foot will clear the ground; this constitutes the *stepping gait* referred to in the section on Neuritis. If sensory impairment is present it will be found in the outer half of the front of the leg and the dorsum of the foot.

The *internal popliteal nerve* supplies the popliteus, tibialis posticus, the calf muscles, the long flexors of the toes, and the muscles of the sole. When paralyzed, flexion of the foot and toes is impossible, and sensation is lost over the back of the leg in its lower part and over the sole. In old cases talipes calcaneus results. The plantar nerves are rarely, if ever, involved alone. Disease of the plexuses outside the canal must be distinguished from lesions inside involving the cauda equina (p. 1102), most commonly these are either a fracture dislocation of one or more lumbar vertebræ below the first; hemorrhage, or tumor. If the first, the diagnosis is easy, as the fractured vertebræ can be easily recognized by inspection, and in doubtful cases, the skiagram. A history of traumatism is important in both fracture and hemorrhage, and the symptoms are usually bilateral, but not always strictly symmetric; the pain is severe. Tumor should be indicated by a slow but progressive development of atrophic paralysis, absence of reflexes, sensory paralysis, intense sacral pain of a radiating character, and often tenderness in the same region. There is also usually sphincter paralysis.

Solution of continuity in an *intercostal nerve*, as in a fracture of a rib, rarely gives rise to any symptom except a small area of anesthesia at the sternal end of the corresponding interspace.

Neuralgic affections of these nerves are described on p. 1041.

II. INFLAMMATION OF THE MENINGES

Meningitis is very rarely a primary condition. Both the dura and pia may be involved. In the former case the inflammation is usually due to some morbid condition of the vertebræ, while in the latter it is secondary to some infection, as in pyemia, sepsis, pneumonia, typhoid, or the acute exanthemata. It may be part of a tuberculous condition (*vide* Tuberculosis, p. 243) or of epidemic cerebrospinal meningitis (p. 85). Injuries also lead to inflammation of the meninges of the cord.

INFLAMMATION OF THE DURA MATER

CEREBRAL PACHYMENINGITIS

Inflammation.—This may be met with on the outer or inner surface (*pachymeningitis externa* or *interna*). Of the external variety the chief causes are (a) traumatism, (b) disease of the bone, (c) syphilis, and (d) middle-ear disease. That due to traumatism is often seen, and in the mildest form is of little moment. When severe and accompanied by fracture with or without displacement, infection of the membranes may either take place at once or later from diseased bone. That form due to caries or any other form of osteitis is always dangerous, owing to the possibility of infection of the diploë. The brain sinuses will then become affected, and infected emboli may pass into the circulation, with the development of pyemia. In the syphilitic variety the inner table of the skull is thickened and roughened, and more or less pus and granular material is found between it and the dura (see also Syphilis of the Nervous System). Sinuses may communicate with the exterior.

The **symptoms** are indefinite in mild cases, and may consist only of *headache*. In the severe forms there are *headache*, *malaise*, *chills*, *fever*, *drowsiness*, and later *stupor*, and rarely *convulsions*, *paralysis*, or other symptoms of compression. The ophthalmoscope may reveal more or less evidence of *choked disk*. Rigors are suggestive of the onset of pyemia.

The **treatment** varies with the cause. Antiphlogistic measures and counter-irritation are of value, and in the severe grades operative interference may be necessary. The internal variety either occurs as a simple inflammation or may be so acute as to cause extravasation of blood. This may organize, and, together with the products of inflammation, cause a pseudomembrane. Rarely is pus found.

Internal hemorrhagic pachymeningitis, or hematoma of the dura mater, is characterized by the formation of a fibrous exudate upon the inner surface of the dura, into which capillaries extend that subsequently rupture. It is found most commonly among alcoholics, the insane, and epileptics. It occurs rarely in childhood.

The **symptoms** are variable. The entire course may be without symptoms, or they may be marked by the existence of other conditions. More frequently there are *headache* and *convulsions*, followed later by *paralyses*, coma, and

death. The location of the lesion causes considerable modification of the symptomatology. In the milder form recovery frequently occurs, or the case may become chronic. If the onset is sudden, the symptoms may resemble those of hemorrhage.

The **diagnosis** is always difficult. In children muscular contractions and convulsions are frequently met with; in adults the slow onset may be the only difference between this condition and an attack of epilepsy. Of course, there is a greater periodicity in the latter; but a repetition of the attacks occurs in hematoma, and, as already stated, the repeated hemorrhages are believed by some to be the cause of the lamination of the false membrane.

The **prognosis** is extremely unfavorable in children, but is much less so in adults.

The **treatment** calls for the use of leeches behind the ears and over the temples, the ice-cap, and counterirritation. Free movement of the bowels should be promptly secured, and later the iodids or mercurials should be administered.

SPINAL PACHYMEINGITIS

Definition.—Inflammation of the dura mater. The dura may be involved on its outer or inner surface (*pachymeningitis externa* or *interna*), or the loose connective tissue between the dura and bony canal may be the seat of a peripachymeningitis.

Pachymeningitis externa is always secondary, and usually results from disease of the vertebræ, due to syphilis, tuberculosis (Pott's disease), or malignant disease, or from pressure due to tumors or to traumatism. It may be either acute or chronic. Of the latter type, cases due to Pott's disease are most common. The membrane is involved to a greater or less extent. The internal surface may escape entirely, or it may be slightly roughened and adherent to the arachnoid; externally, however, the dura is usually thickened, rough, and covered with a cheesy material.

Pachymeningitis interna was first described by Charcot in 1871, and named *pachymeningitis cervicalis hypertrophica*. It is of obscure origin, but traumatism, alcoholism, and syphilis have been given as causes. The dura is generally much thickened, and gives the impression of being made up of a number of concentric layers. Hemorrhages may occur within the dura or within the newly formed tissue. The pia is only involved to a slight degree, as a rule, but becomes adherent to the dura. Areas of degeneration may occur in the cord, as may also dilatation of its central canal. As implied by the name, this variety of pachymeningitis is found chiefly in the cervical region, and the clinical symptoms result from involvement of the nerve-roots and compression of the cord. It is a chronic process, and has been divided into three periods, as follows: (a) The *painful period*, lasting, as a rule, two or three months, in which severe neuralgic pains exist, their location being determined by the roots involved. They are mostly in the occiput and upper extremities. Early there may be hyperesthesia, numbness, tingling, and, rarely, a herpetic eruption. (b) The *Paralytic Period*.—As a result of compression of the motor roots an atrophic paralysis of the upper extremities develops. A peculiar selective tendency is manifested, the distribution of the median and ulnar nerves being principally involved. This results in a modified "claw-hand" deformity and in an overextension of the wrists, with flexion of the fingers. Anesthesia may be noted. (c) *Spastic Paraplegia*.—This results when the compression has produced degeneration of the cord. Generally, there are paresis of the lower extremities and increased reflexes, but no muscular wasting, since the trophic centers are intact. Occasionally, however, anesthesia and

paralysis of the legs and bladder develop, bed-sores following, and finally death from exhaustion.

The *prognosis* is unfavorable, practically all cases terminate in death, but the duration is variable.

The *diagnosis* must be made from amyotrophic lateral sclerosis, vertebral caries, syringomyelia, and from pressure by tumors. Amyotrophic lateral sclerosis does not give rise to sensory disturbances; bulbar symptoms are often present, the lower extremities may atrophy, and the bladder functions are preserved. In vertebral caries tenderness on jarring will be present, and a skiagram will probably show evidence of bone disease. Syringomyelia induces characteristic symptoms of loss of temperature and pain sense with the preservation of tactile sense (dissociation of sensation), although this may rarely be present in pachymeningitis, but severe neuralgic or radiating pains are rare in syringomyelia. From tumor the diagnosis may be difficult, the symptoms in this, however, usually develop more gradually and at first are unilateral.

Treatment is not of much avail. Potassium iodid and mercury are the chief measures. In cases otherwise hopeless an exploratory operation is sometimes justifiable.

LEPTOMENINGITIS

Definition.—Inflammation of the pia mater. This may be either acute or chronic.

CEREBRAL LEPTOMENINGITIS

Cerebral leptomeningitis is an inflammatory condition of the pia arachnoid; it occurs in various forms, that may be classified either according to the distribution of the process, into meningitis of the convexity, of the base, or cerebrospinal meningitis, or according to the cause.

Etiology.—As it is infectious, this is always micro-organismal. It is customary to distinguish between the forms produced by the pyogenic micro-organisms and by the tubercle bacilli. Among the former the most important are the pneumococcus, the meningococcus, the staphylococcus, and the bacillus of influenza, but a great variety of other bacteria have been found, such as the colon bacillus, the typhoid bacillus, and others in rare or isolated instances. The method of access to the meninges varies, either along the blood or lymph-channels from some focus of infection, as the lungs, the nasal cavities, or in the course of an infectious process that gives rise to bacteremia, as pyemia; or by direct extension, as in middle-ear disease, or disease of the sinuses of the face. Meningitis, particularly the tuberculous variety, may follow injuries to the head. It may be due to syphilis. Purulent meningitis may occur at any age. Tuberculous meningitis is more common in childhood and is described on p. 243.

Pathology.—In the extent and degree of the inflammation great variations exist. It may be either (1) limited to the convexity, with or without involvement of the sides; (2) limited to the base; or (3) general, involving both convexity and base. In the early stages and in the mild forms there may be no more than an injection of the part. Later, inflammatory products are met with, usually following the course of the meningeal vessels, but sometimes covering considerable areas. This form of leptomeningitis, unlike the tuberculous variety, is prone to attack the convexity of the brain.

Symptoms.—These are very varied, and naturally depend on the *seat* and *extent* of the inflammation. Those cases in which symptoms pointing to involvement of the base occur need not be discussed here, since they are

considered in detail under the tuberculous variety. In any case *headache*, localized or general, is usually present. In children too young to talk its presence is often indicated by crying or putting the hand to the head. *Delirium*, *insomnia*, and *coma* are also met with in different cases. There is more or less *fever*. *Constipation*, a *coated tongue*, *vomiting*, a *rapid pulse*, are usual, and the *tâche cerebrale* may be elicited. Spasmodic movements may occur, or even *general convulsions*. Of course, in cases of inflammation of the base, the cranial nerves become affected, and we have *ptosis* or *strabismus*, *facial spasm* or *palsy*, and, if the fifth nerve is involved, *sensory* and *trophic* changes. The head is usually retracted until it seems to bore into the pillow; the muscles of the back of the neck are tense; the spine is often rigid; the abdomen retracted, and the limbs flexed. The tendon reflexes are exaggerated and cutaneous irritability greatly increased. *Kernig's sign* consists in the inability of the patient to straighten the leg when the thigh is flexed to a position of 90 degrees to the axis of the body. It is nearly always present in acute non-tuberculous meningitis, but often absent in the tuberculous form; occasionally it may be found in focal encephalitis, either acute or chronic, and even in acute infectious disease—typhoid fever. It is, therefore, valuable as a suggestive sign of meningitis, but can no longer be considered pathognomonic. Brudzinski's sign may be present (p. 90). If a suppurative ependymitis is present, a condition similar to acquired hydrocephalus occurs, except the fluid within the ventricles is purulent. This has been termed pyocephalus. Its occurrence is indicated by a return of symptoms after recovery has apparently commenced. The spinal fluid will be clear. A type frequently found in young children, and thought by many to be a form of sporadic cerebrospinal meningitis (p. 85), consists of an inflammation confined to the meninges of the posterior part of the base of the brain from the optic commissure to the medulla. From its location hydrocephalus frequently develops; blindness, due to pressure on the optic chiasm, also is common. The intense retraction of the head is a characteristic symptom. It is known as *posterior basic meningitis*.

Diagnosis.—Where no etiologic hint can be obtained the diagnosis is generally in doubt for two or three days. There may be nothing more than a reflex irritation (dental or gastro-intestinal), or possibly one of the infectious fevers. The symptoms should be studied in their entirety; one or two supposedly pathognomonic signs should not be allowed to cloud our vision. In some cases it may be necessary to distinguish meningitis from the so-called *serous meningitis* (p. 1081). Meningitic symptoms, associated with marked delirium, may occur in the course of acute articular rheumatism. In this condition the cerebrospinal fluid will be clear (p. 1083). The condition is known as cerebral rheumatism. It must also be borne in mind that meningeal symptoms are simulated by the infectious diseases; this is especially so in children. The condition is known as meningism or meningismus. The spinal fluid will be negative (p. 1083). The glycol-tryptophan reaction¹ has been advocated as a test for all forms of meningitis. Major and Nobel found it positive in all of a series of 17 cases, mostly tubercular. It is obtained by placing 1 c.c. of the suspected cerebrospinal fluid in a test-tube with an equal quantity of glycol-tryptophan, then 1 c.c. of toluol is added. The mixture is placed in an incubator for three hours, after which a few drops of dilute acetic acid are added. An oversaturated solution of calcium chlorid is then added drop by drop, and a red color is produced if free tryptophan is present, *i. e.*, in meningitis. The test should be made with various dilutions with sterile normal salt solution from 1 : 200. Having made the diagnosis of meningitis, it becomes important to **differentiate** the *tuberculous* from the *non-tuberculous*

¹ *Archives Intern. Med.*, September, 1914, p. 383.

variety. The family history is of importance. In *tuberculous meningitis* the focal symptoms usually appear early, and are due to involvement of the cranial nerves at the base of the brain, chiefly those controlling the eye. The eye-grounds often show a slight perineuritis without choked disks, and perhaps one or more miliary tubercles. There is sometimes a mild form of confusional delirium, often preceding the appearance of focal symptoms. The leukocytes are slightly, if at all, increased. There is rarely rigidity of the neck. In other forms of meningitis this appears early; the optic nerve shows intense inflammation and there is usually pronounced leukocytosis. Examination of the fluid withdrawn by lumbar puncture (p. 1083) is important. A differential count of the leukocytes in the spinal fluid should always be made (Cytodiagnosis, see p. 1083).

Prognosis.—This is always grave. A percentage of cases of epidemic cerebrospinal meningitis, varying with the severity of the epidemic, may recover. In all other forms any termination, except in death, is exceedingly exceptional. Remissions frequently occur in the symptoms, and the course may be very prolonged.

Treatment.—We have no specific, and all that can be done is to meet the symptomatic indications. Absolute quiet in a darkened room, an ice-cap to the head, and the internal use of full doses of hexamethylenamin (urotropin) and repeated lumbar puncture may be of service. The bowels must be kept free by salines and fever reduced, if necessary, by cool sponging. Opium may have to be given for pain. The introducing into the spinal cord of serums other than the meningococcic, according to the cause of the meningitis, may be tried. Anti-influenzal serum is often efficacious. If pyocephalus occurs the serum must be introduced into the ventricles.¹ If of syphilitic origin, either mercury should be used by inunction or injection or arsphenamine employed. In certain cases—*e. g.*, those secondary to middle-ear disease—either opening the skull above and below the tentorium and draining,² or the operation of Haynes,³ which consists in draining the cisterna magna in the posterior fossa, may seem justifiable, although the results have not been particularly encouraging. When in doubt the physician should not delay action until too late, but should call in a surgeon while there is still hope for some benefit.

The treatment of the epidemic and tubercular forms is detailed on pages 85 and 243.

SEROUS MENINGITIS

(*Meningitis Serosa; Wet Brain*)

A condition, first described by Quincke, which in the acute form may arise spontaneously or follow various infective processes. Chronic alcoholism is a frequent cause. The symptoms resemble those of acute cerebral meningitis, and lumbar puncture may be necessary to establish the diagnosis, in serous meningitis, the fluid being clear, not containing organisms, and escaping under great pressure. The more chronic type closely simulates tumor of the brain, especially a subtentorial growth, as paralysis of cranial nerves, choked disk, convulsions, and ataxia may all be symptoms of this condition.

The *symptoms* are apt to fluctuate, and if they develop acutely after an infection of some sort it would be in favor of serous meningitis. In some cases

¹ *Progressive Medicine*, March, 1917, p. 37.

² Day, *Annals of Otology, Rhinology, and Laryngology*, June, 1911.

³ *Trans. Amer. Laryngol., Rhinol., and Otolog. Soc.*, 1912, and *Prog. Med.*, March, 1913, p. 43.

an inflammation of the ependyma exists, and internal hydrocephalus (p. 1113) may follow.

The *prognosis* is doubtful, but recovery takes place in a fair proportion of cases. In the alcoholic type the greater the rigidity and retraction of the head, the worse the outlook.

Quincke advises mercurial inunctions in all cases. Counterirritation to the back of the neck and cold to the head may also be used. Lumbar puncture is of great service. The bowels should be kept free and the diet liquid, but liberal in quantity (hot milk, eggs, broths). In the alcoholic cases the inunctions should be omitted and strychnin in full doses (gr. $\frac{1}{80}$ every three hours) given.

ACUTE SPINAL LEPTOMENINGITIS

(*Acute Spinal Meningitis*)

Etiology.—This is always micro-organismal, and a great variety of bacteria have been discovered. It is rare unless associated with cerebral meningitis and the causes are similar (p. 1079).

Pathology.—The vessels are injected, the membrane becomes cloudy, a serofibrinous or purulent exudate either surrounds the cord or may only exist in patches, and in the more severe cases the cord itself is involved (*meningomyelitis*). The spinal meninges alone may be involved to a greater or less extent, but, as a rule, the cerebral meninges are similarly involved. Tubercles will be found in the tubercular form. It should be remembered that many cases presenting clinically the picture of meningitis show absolutely no gross *postmortem* lesions of the cerebral or spinal membranes. This may occur from any toxemia, but especially in pneumonia, typhoid fever, influenza, and rheumatism. No lesions, not even microscopic, are found. This condition is termed *meningismus*.

Symptoms.—These are chiefly pain in the back, often excruciating, with fixation, retraction of the head, tenderness on pressure along the spine, tremor or spasm of the muscles, and various sensory disturbances. Reflexes are early increased, and later diminished or absent. Should the cord be involved, paralysis, incontinence of urine and feces, and even bed-sores may develop (pp. 1094, 1095). The symptoms are more fully discussed in speaking of the tuberculous and epidemic varieties.

Diagnosis.—It is often very difficult to differentiate the several varieties of spinal meningitis, and equally so to decide whether the case is actually meningeal when some other disease is present (glycyl-tryptophan test, p. 1080). The tuberculous form is readily diagnosed, especially if any collateral evidence of tuberculosis exists, and it rarely occurs except with involvement of the cerebral meninges. It is a point of some value in the diagnosis to note the absence of marked leukocytosis in the cerebrospinal fluid obtained by lumbar puncture in tuberculous and its presence in purulent meningitis. The presence of *Kernig's sign* is in favor of cerebrospinal meningitis.

Spinal paracentesis or *lumbar puncture*, first introduced by Quincke of Kiel in 1891, is a most valuable diagnostic measure and simple of application. It is performed as follows: The patient either sits up or lies upon the left side, with the back arched and the knees flexed against the abdomen. The spine of the fourth lumbar vertebra should be located (a line drawn from one posterior superior spine of the ilium to the other passes across it), and the puncture made at the level of its lower end. The needle should be inclined at an angle of about 45 degrees to the surface of the skin, and should be thrust in a distance of from $2\frac{1}{2}$ to 3 inches. The most scrupulous asepsis must be observed. The spinal fluid flows readily, either in a stream when the pressure is high,

or drop by drop if it is normal. In purulent meningitis it is cloudy, contains pus-cells, and does not reduce Fehling's solution; in tuberculous meningitis it is usually clear and does reduce Fehling's solution; in cerebral hemorrhage it may be bloody, but as admixed blood may be due to the injury of a vessel by the needle, this sign should be used with caution. The quantity obtained varies from 2 or 3 to 80 or 90 c.c. After centrifugation a differential count of white cells should be made. An excess of lymphocytes associated with symptoms of meningitis (see p. 1090) indicates a tubercular infection; an excess of polymorphonuclear cells, a pyogenic infection. Cultures should be made and the sediment or coagulum stained for bacteria. In meningismus the fluid is practically normal. Often there is great relief from the puncture, and occasionally, in serous meningitis, the patient appears to be permanently benefited.

The **prognosis** is unfavorable as a rule, particularly in the tuberculous form.

The **treatment** is the same as that of cerebrospinal meningitis (*vide* pp. 94, 1081).

CHRONIC LEPTOMENINGITIS

This disease may follow the acute form or be due to chronic alcoholism, syphilis, trauma, disease of the cord or vertebræ.

Pathology.—The pia is cloudy and swollen, and often adherent to the arachnoid, or all three membranes may be glued together. They are usually injected. Usually there is considerable proliferation of fibrous tissue. The periphery of the cord is also occasionally affected. A condition known as *circumscribed serous spinal meningitis* may be here mentioned. It may follow either traumatism or infectious diseases. When the dura is slit, its opening is filled by a more or less opaque pia that bulges forth under tension of the contained fluid which is clear.

Symptoms.—These are not well marked. Unless the nerve-roots are involved the symptoms are slight or none at all exist; however, pains of a radiating character, stiffness, tremors, hyperesthesia, herpes, and even paralyses, may occur. The course is slow, and may extend over many years. Idiopathic circumscribed spinal serous meningitis is described in connection with spinal tumors, as the symptoms of the two are practically the same (p. 1100).

The **prognosis** is unfavorable ultimately.

The **treatment** consists in the use of iodids and mercury internally, and the application of baths, and counterirritation along the spine.

III. DISEASES OF THE SPINAL CORD

HEMORRHAGE INTO THE SPINAL MENINGES

(*Meningeal Apoplexy; Hematorrachis*)

(a) **Extrameningeal hemorrhage** occurs when the blood is between the dura and spinal cord.

(b) **Intrameningeal hemorrhage** is that in which the bleeding takes place beneath the dura.

Large hemorrhages are more common in the extrameningeal form; they result from trauma or rupture of an aneurysm. The peridural space will

accommodate a large amount of blood without giving rise to pressure symptoms. Caries of the vertebræ or carcinoma may cause hemorrhage by erosion and rupture of a blood-vessel. The intrameningeal form may result from meningitis, from trauma, or may occur as a complication of any of the infectious or hemorrhagic diseases. In such cases the hemorrhages are small and scattered. It may also occur in convulsive disorders or in strychnin-poisoning. Rupture of an aneurysm at the base of the brain may give rise to extensive hemorrhage; blood may also pass into the spinal cerebrospinal fluid from either a ventricular or subdural cerebral hemorrhage.

Symptoms.—When the hemorrhage is large enough to cause pressure the symptoms are very acute, apoplectiform indeed, but consciousness is preserved. Generally, however, they are quite indefinite. In any case they depend upon the degree and location of the compression. At first they are irritative—viz., hyperesthesia, paresthesia, neuralgic pains that are radiating in character, muscular irritability, tremors, or contractions. If subdural, the fluid obtained by lumbar puncture will probably contain blood. Later, paralytic symptoms may develop, as anesthesia and bladder and bowel symptoms, girdle-pains, or, when the lesion is high up, interference with respiration and pupillary changes.

The **diagnosis** is often difficult, unless the onset is sudden and explosive.

The **prognosis** depends on the cause and extent of the hemorrhage. If small in amount, absorption is usually prompt, with little or no disturbance of function remaining.

The **treatment** consists of rest, ice to the spine, and morphin to relieve pain; later mercury and the iodids may be given to hasten absorption. Local measures, such as leeches, cupping, etc., or general styptics, such as ergot and calcium chlorid, are of very doubtful value; although the latter may be used if the hemorrhagic diathesis is present. In certain cases operative procedures, with a view to removing the clot, may be justifiable.

HYPEREMIA AND ANEMIA OF THE CORD

These may be due to qualitative and quantitative changes in the blood, and morbid conditions of the vessel walls. They give rise to no characteristic symptoms unless softening or degeneration occurs.

The blood-vessels may be the seat of peri- or endarteritis, and rarely miliary aneurysms may develop. Embolism and thrombosis also occur, the former much less frequently than the latter, which is prone to follow sclerotic changes in the vessels, giving rise to ischemia and ultimately to softening (p. 1093). Degenerative changes in the cord may be caused by anemia (p. 1109).

HEMORRHAGE INTO THE SPINAL CORD

(*Hematomyelia; Spinal Apoplexy*)

This is of very much less frequent occurrence than cerebral hemorrhage. It is usually due to traumatism, but may possibly follow some severe strain or overexertion, probably only when the vessels are atheromatous. Hemorrhage may occur in cases of myelitis, epidemic cerebrospinal meningitis, syringomyelia, tumors of the cord, convulsive disorders, and infectious diseases.

it is, however, usually small. If the hemorrhage is extensive, disruption of more or less cord substance necessarily follows. An area may exist large enough to cause distention of the cord without rupture, and from this extravasations may take place in the cord substance above and below. Unilateral hemorrhage may occur, the gray matter being chiefly involved. If of recent origin, fresh blood will be found *postmortem*; but if of long standing, a brown or brownish-yellow area will be noted, consisting of disintegrated blood-corpuscles, cell detritus, and hematoidin crystals.

The *symptoms* necessarily vary according to the region involved, the gray matter of the cervical region being the most frequently affected. The onset is always sudden, the symptoms rarely requiring as long as a half-hour to develop. They consist of a flaccid paralysis of the limbs below the seat of the lesion, loss of reflexes, and probably of sensibility. The urine and feces will be retained. Consciousness is not lost. If in the lower cervical region, contraction of the pupils and narrowing of the palpebral tissues will be observed, owing to involvement of the oculopupillary fibers at the eighth cervical and first dorsal segments (cervical sympathetic nerve). If death does not occur, the symptoms gradually more or less subside, and ultimately resemble those of acute myelitis (p. 1093). As the hemorrhage is most often in the gray matter, dissociation of sensation (preservation of tactile and loss of pain and temperature sense) will result; atrophy of the muscles supplied by the affected segments (p. 1030) will also result; below the seat of the lesion the paralysis becomes spastic with increased tendon reflexes. If one side of the cord is principally involved, the Brown-Séquard syndrome (p. 1034) results.

The *diagnosis* must be made in acute cases from meningeal hemorrhage and, if traumatic, fracture of the vertebra. The presence of severe lancinating pain, muscular twitchings, and a less degree of paralysis distinguishes the former. The latter can usually be determined by the characteristic deformity, as determined by inspection and the skiagram—hemorrhage, of course, can coexist with fracture. The residual symptoms, if the patient survive, may be mistaken for syringomyelia and myelitis; the history of traumatism and sudden onset will distinguish it from the former. In the latter it may be difficult, as hemorrhage frequently precedes the development of myelitis in traumatic cases. A history of apoplectiform onset is evidence that the primary condition at least was hemorrhagic.

The *prognosis* during the acute stage is doubtful, death may occur from exhaustion or septic infection due to bed-sores or cystitis. If this stage is survived, a considerable degree of power may return and the patient get about with a more or less spastic paraplegia, and if in the cervical region, atrophic paralysis of the arms and hands.

Treatment.—Rest, ice locally, attention to bladder and bowels, and the internal use of calcium salts and opium make up the treatment of the acute stage; afterward the treatment is similar to that of myelitis (p. 1095).

CAISSON DISEASE

(*Diver's Paralysis*)

Definition.—A paralytic condition caused by sudden transference from an abnormally great atmospheric pressure to one of normal intensity.

The **etiology** of the disease is very clear, and certain predisposing factors are worthy of note. Divers are more apt to suffer if they have been working

at extreme depths, particularly if the period of exposure to great pressure has been prolonged; very moderate pressure will sometimes produce symptoms if continued for a sufficient length of time, and short periods of rest do not prevent the development of the disease. Ordinarily, it can be said that unless the pressure exceeds two and one-half or three atmospheres no danger may be apprehended. Alcoholism is a predisposing cause.

Pathology.—Two theories have been advanced to account for the condition. One is that under the high pressure the blood becomes overcharged with nitrogen gas; when the pressure is relieved this is liberated, causing emboli, which block up the spinal vessels. The other is that the blood is driven from the surface, causing distention of the vessels with paralysis of their walls; when the air-pressure diminishes they are unable to accommodate themselves to the changed condition, and stasis with congestion and hemorrhages result. Both factors are probably accountable. Small hemorrhages and laceration of nerve-fibers have been found in the cord.

The **symptoms** vary greatly in intensity. In the mildest form they consist of *neuralgic pains in the joints*, sometimes with slight articular swelling, *headache, giddiness*, and a little *tinnitus*. These pains may become more violent, particularly in the loins, and be followed by a gradual *loss of power* and by *anesthesia* in the limbs; these symptoms may disappear in a few hours or become more severe, with the development of *complete paralysis* and interference with the action of the sphincters. This paralysis usually assumes the form of *paraplegia*; *monoplegia* and *hemiplegia* also occur, and sometimes there are complete paralysis and anesthesia of all four extremities and of the trunk. In the most severe cases *cerebral symptoms* are also present, consisting of sudden loss of consciousness, profound coma, irregular respiratory action, and finally, after a short time, death from cardiac failure.

The **diagnosis** is very easy. It is possible, however, that an attack of *apoplexy* should occur in a man who has been under water, and the patient should always be examined for the presence of this or some other organic lesion.

The **prognosis** varies with the intensity of the symptoms. The lighter forms consist merely of joint-pains and slight dizziness that usually pass away in the course of a few hours. Paraplegias or hemiplegias, developing slowly and not assuming a severe form, are also transient in character. A more severe paraplegia is usually permanent, although some improvement may be expected. The apoplectic forms are almost invariably fatal in the course of a few hours.

The **treatment** consists, first, of prophylactic measures. In all places where caisson work is carried on one or more locks should be provided in which the pressure can be gradually reduced until it is approximately that of the atmosphere. Divers should be instructed to come slowly to the surface. If the pressure exceeds three atmospheres, the maximum length of the working period should not be more than one hour, and several hours should be permitted between the descents. A chamber should also be provided in which a man who exhibits symptoms of the disease can be once more subjected to a pressure greater than that of the atmosphere, as this usually causes an arrest of the process. When, however, the condition resembles that of acute myelitis, the treatment is purely symptomatic. It consists of rest, careful hygiene, and a stimulating diet. Stimulating liniments and the rapidly interrupted faradic current may be used for the pain. If the heart is not weak, phenacetin and similar drugs may be used. If it is, strychnin and caffein may prove useful. In the comatose cases enemata of hot coffee should be used and artificial respiration and inhalation of oxygen may be necessary. For the resulting paralysis the treatment is that employed for chronic myelitis.

BULBAR PARALYSIS

(Glossolabiolaryngeal Paralysis)

Definition.—Bulbar paralysis is usually termed a disease of the brain, but as the pons and medulla are anatomically and physiologically parts of the cord, it seems more logical to discuss it here. It is an acute or chronic disease due to involvement of the motor nuclei of the medulla oblongata, and is characterized chiefly by a difficulty of speech and of deglutition. Three varieties have been described:

1. **Sudden or apoplectiform**, this being due to hemorrhage, embolism, or thrombosis either of a branch of the basilar or inferior posterior cerebellar arteries. In the latter case anesthesia of the face, ataxia, and other symptoms occur (p. 1122). The onset is always sudden, often with vertigo, and without loss of consciousness. The power to articulate is impaired or lost. The lips and tongue are involved, and hence the pendulous lower lip, the dribbling of saliva, and the atrophy of the lingual muscles. There are dysphagia and generally frequent attacks of choking.

The *symptoms* are less characteristic than those of the degenerative form. They are less regular in type, and usually are wide-spread at first; later some improvement takes place. In other cases, after more or less of a respite, degeneration sets in and they grow progressively worse. Death, however, usually occurs speedily.

The *diagnosis* of this type is not usually difficult. "Pseudobulbar paralysis" must be borne in mind (p. 1117). There is great danger to life for some little while in these sudden cases. Later the prognosis is rather more favorable than in the other forms.

2. **Acute Inflammatory.**—Here the onset is less abrupt, requiring a few days to a week to develop, and follows either one of the infectious diseases, the excessive use of alcohol, or lead-poisoning (polio-encephalitis inferior, p. 1127). But for this fact the symptoms are much the same as in the preceding form. It may be associated with acute anterior poliomyelitis (p. 1090).

3. **Chronic Bulbar Paralysis.**—This condition occurs chiefly in males beyond middle life. The cause can seldom be discovered, though certain cases seem to be of toxic origin. It may develop in the course of progressive muscular atrophy, amyotrophic lateral sclerosis, and insular sclerosis.

The *symptoms* are bilateral, the tongue being usually the first to suffer. The patient may notice that he cannot speak for any length of time without fatigue, and that he will then articulate indistinctly. Soon he observes that there is a marked and progressive *impairment of speech*. The muscles of the lips and other muscles of the lower part of the face atrophy. He can no longer whistle. Speech is rendered still more defective owing to paralysis of the lips. The lower lip droops, and the saliva constantly dribbles from the mouth and may be greatly increased in amount. *Difficulty in swallowing* is always present to a greater or less degree. Owing to the lingual paralysis, the tongue can neither be protruded nor can it be used to manipulate the food and make a bolus. It is atrophied and the mucous membrane is wrinkled. *Fibrillar tremors* are present and reactions of degeneration may occur. The *larynx* is involved, so that phonation is imperfect, but it is not so marked as the implication of other parts. Particles that enter the larynx cannot be ejected owing to motor paralysis. There are no sensory symptoms and the power of taste is normal. The mind generally remains clear, though the patient is often emotional, and cries or laughs without apparent cause. The *course* of the disease is slow, and death is usually due either to inspiration pneumonia or to interference with respiration or circulation.

The **diagnosis** is not difficult; as a rule the bilateral character of the

symptoms rendering them distinctive. In the *pseudobulbar form* the limbs are often paralyzed also (double hemiplegia). The tongue is not atrophied, the muscles of the face do not show changes in their electric reaction, and there is usually a history of successive apoplectic attacks (p. 1117). *Tumors* rarely, if ever, give rise to such regular bilateral symptoms. It may also have to be distinguished from myasthenia gravis (see p. 1213).

Treatment.—The disease is incurable. Hypodermics of strychnin or of strychnin, morphin, and atropin are of value in controlling the salivary flow. Electricity is of no value. Semisolid food is probably the most readily taken, and it is often necessary either to use an esophageal tube or to employ rectal alimentation.

ACUTE ANTERIOR POLIOMYELITIS

ESSENTIAL PARALYSIS OF CHILDREN

(*Atrophic Spinal Paralysis; Infantile Paralysis*)

Definition.—An infectious febrile disease of more or less rapid onset, usually associated with muscular paralysis and atrophy, occurring chiefly in children, and most frequently in those under three years of age.

Etiology.—Flexner and Noguchi¹ have cultivated an organism which fulfils the requirements necessary to prove a germ the cause of a disease. It is filterable, exceedingly minute, and is visible under high power of the microscope. Rosenow, Towne, and Wheeler² have also isolated a peculiar streptococcus from the throats, tonsils, abscesses in tonsils, and the central nervous system of those suffering with the disease which produced paralysis in inoculated animals. They state that this organism, while larger than that discovered by Flexner and Noguchi, may be the same, the latter being the form it takes under anaërobic and certain culture conditions. Amoss,³ however, in a series of experiments, shows that the streptococcus isolated from cases of poliomyelitis is not the organism causing the disease and that it differs in many ways from the filterable virus. Nuzum and Herzog⁴ have also isolated and cultivated an organism from similar material and the cerebrospinal fluid which answered the same tests. The disease has been produced in monkeys by intracerebral inoculation with an emulsion of an affected spinal cord. Monkeys have also been inoculated with the secretions from the nasopharynx of those suffering from the disease. The virus will live in the intestines and pass from the body in the feces.⁵ Washings from the nasopharynx of those brought in contact with the disease but who did not contract it have caused it in inoculated monkeys,⁶ thus acting as “carriers.” Whether or not the disease is communicable by direct contact is disputed. Many authorities believe that it is, but if so it is not to the same degree as many other diseases. The virus enters the body by way of the mucous membrane of the throat and nose, and from there spreads by the lymphatics.⁷ Possibly it may enter by other avenues, but such are not now known. There is no positive knowledge that the bites of insects communicate the disease.⁸ The disease may occur at any

¹ *Jour. Exper. Med.*, October, 1913, p. 461.

² *Jour. Amer. Med. Assoc.*, October 21, 1916, p. 1202.

³ *Jour. Exper. Med.*, 1918, xxvii, 443.

⁴ *Jour. Amer. Med. Assoc.*, October 21, 1916, p. 1202.

⁵ Flexner, Clark, and Dochez, *Jour. Amer. Med. Assoc.*, July 27, 1912, p. 273.

⁶ *Jour. Amer. Med. Assoc.*, January 18, 1913.

⁷ Flexner and Amoss, *Jour. Exper. Med.*, 1914, p. 249.

⁸ *Jour. Amer. Med. Assoc.*, July 22, 1916, p. 280.

age, but by far the greatest number of cases occur before the third year of life; they are about equally distributed between the two sexes. Later in life the condition is more common in males, chiefly between the ages of ten and twenty-five. It is rare after this period. Epidemics occur, the first recorded one occurring in Sweden in 1881. In the United States the first occurred during the summer of 1894. Dr. Caverly, of Rutland, Vt., then reported 126 cases occurring in Otter Creek Valley, a limestone region of Vermont. The disease appears to be becoming more common and epidemics more frequent. They have been observed at various times in all parts of the world. It is especially apt to occur in warm weather. Traumatism may be a predisposing factor. The acute infectious diseases may cause a symptom group resembling the specific disease.

Pathology.—The parenchyma of the heart, liver, and kidneys are the seat of cloudy swelling, and the lymph-nodes and spleen show hyperplasia and proliferated endothelial cells.

Macroscopically, the cord and meninges are congested. A similar condition may be found in the brain cortex, basal ganglia, ventricles, cerebellum, pons, medulla, and the nerve ganglia. The entire cerebrospinal axis is edematous. Sections of the brain and cord appear translucent and edematous and punctate hemorrhages may be seen. It is important to remember that the entire nervous system except the peripheral nerves may suffer, but the cells of the peripheral motor neurons suffer most, and that the symptoms most prominent are those which follow their injury.

Microscopically, the perivascular lymph-spaces in the regions above mentioned are found filled with cells, first polymorphonuclear leukocytes, later endothelial cells and lymphocytes. The vessels are congested, their walls degenerated, with rupture of and hemorrhage from the capillaries. Degeneration and destruction of the ganglion cells and of the nerve-fibers in the anterior roots and a round-cell infiltration of the pia-arachnoid are found. These changes are most pronounced in the anterior gray matter of the lumbar and cervical enlargements, but the white matter may also be affected. The pons and medulla may also show similar changes. The meninges are first affected and the nerve-cells are involved secondarily to the changes in the blood-vessels, their loss of function and degeneration being due to lack of nutrition. In old cases round cells and connective tissue take the place of the destroyed nerve-cells and fibers.

Symptoms.—The period of incubation ranges from two to thirty days, usually not more than eight. The onset is generally acute, and may be sudden. Constitutional symptoms are present as a rule. In typical cases the sequence is as follows: Fever (usually slight), malaise, possibly vomiting (especially in children), diarrhea or constipation, headache, and restlessness. Evidences of nasopharyngeal inflammation may be present. In a few hours or after one or two days paralysis supervenes and quickly spreads, involving a greater or less area; it then remains stationary for from two to four days to from five to eight weeks, when improvement takes place, beginning in the part last affected. During this period the patient may be stuporous. In some cases, after a most trifling indisposition over night, paresis is met with in the morning. In a few weeks only that portion remains paralyzed that is to be permanently damaged. The paralysis may either ascend or descend, as in Landry's disease (p. 1092). Wasting of the muscles will be noticed in a week or two after the onset of paralysis; these become flaccid and give the reactions of degeneration. Sensory symptoms are very rarely present. The reflexes are lost,¹ both superficial and deep, and later contractures, due to the overaction of unopposed muscles, may develop and result in various deformities.

¹ In the early stages they may be increased.

The growth of bone is seriously impaired in some cases. Atypical forms occur, especially during epidemics. These are: (1) The *arrested* or *abortive type*, which consists of constitutional symptoms, possibly general hyperesthesia, but no paralysis. Such cases may transmit the disease, and will show the characteristic changes in the cerebrospinal fluid. (2) *Acute bulbar*, in which involvement of cranial nerve nuclei occurs. The seventh nerve may be the only one affected. (3) *Encephalic*, characterized by involvement of the cortical cells. (4) *Meningitic type*, in which general hyperesthesia, retraction of the head, and other meningitic symptoms occur. (5) *Neuritic type*, the symptoms of which simulate those of multiple neuritis, but in which the nerves, if examined microscopically, show no pathologic changes.¹

Diagnosis.—Usually this is not difficult except, possibly, for the first few days in some cases. Before the occurrence of paralysis in suspected cases examination of the cerebrospinal fluid, obtained by lumbar puncture, is of service. It is especially important to remember this during epidemics, and to perform the operation early in suspected cases whenever possible. By this means the abortive forms may be recognized. In this stage it may be slightly turbid, but is usually clear, contains a moderate increase of cells, mostly mononuclear, and globulin, reduces Fehling's solution and may show a fibrin web formation. Bacteria are absent, and when paralysis ensues all of these changes soon disappear.² In the various forms of meningitis except the tubercular the fluid is cloudy, contains more protein and cells, which are mostly polymorphonuclear, and does not reduce sugar well. The fluid of tubercular meningitis closely resembles that from poliomyelitis, but usually escapes under greater pressure. It may be impossible to distinguish the two except by inoculation of animals, the tuberculin tests, finding the bacilli in the fluid, and the clinical symptoms. In meningitis the fluid is much increased in amount but otherwise negative. Neustaedter³ has prepared a possibly specific antigen which he thinks will prove valuable, as it fixes complement, in diagnosing acute poliomyelitis. He has called attention to an anemic, glistening, edematous condition of the mucous membrane of the nasopharynx, with a serous frothy transudate in the early or prodromic period.⁴ Close scrutiny will enable one to differentiate between this disease and a pseudopalsy the result of pain on active or passive motion, as seen in rickets, scurvy, and in hip-joint disease. From multiple neuritis it is distinguished by the absence of tenderness over the nerve-trunks and the fact that in neuritis the symptoms are progressive and not retrogressive, as they are in poliomyelitis. The symptoms of the cerebral palsies of childhood are given on page 1123, and of transverse myelitis on page 1094.

Prognosis.—Some impairment of motion and more or less wasting of the muscles almost invariably remain. Danger to life varies in different epidemics. In some the death-rate is less than 10 per cent., in others it may be 25 per cent. One attack confers immunity. Death may occur from either involvement of the bulbar nuclei or violence of the toxemia. Marked improvement in power may result several years after the oncoming of the disease if proper treatment is persisted in. A few cases completely recover.

Treatment.—Owing to the possibility of the disease being communicable during the acute stage, the patient should be isolated and the discharges disinfected, as in other similar diseases. The nasopharynx especially should be

¹ Sharp, *Jour. Nerv. and Ment. Dis.*, May, 1913, p. 289; Leopold, *Jour. Amer. Med. Assoc.*, September 28, 1912; also, *Amer. Jour. Med. Sci.*, cxlvi, 1913, p. 406.

² Flexner and Clark, *Jour. Amer. Med. Assoc.*, February 25, 1911, p. 586, and Kolmer *et al.*, *Amer. Jour. Med. Sci.*, November, 1917, p. 720.

³ *New York State Jour. Med.*, 1918, xviii, 328.

⁴ *New York Med. Jour.*, September 14, 1912, p. 519; *Ibid.*, July 22, 1916, p. 145.

kept as clean as possible with washes containing menthol. If fever is excessive, cool sponging or an ice-bag to the head may be employed. No procedure is of greater value than lumbar puncture. It is of especial value in the meningitic type, but is valuable in all. If done early it may stop the development of serious symptoms. It should be repeated at intervals of from one to several days, according to the condition of the patient, until acute symptoms have disappeared. The injection into the spinal canal of the blood-serum of one who has had the disease has been advocated.¹ This, of course, must be sterile, and the possibility of the donor having had syphilis must be determined by a previous Wassermann test. It need not be inactivated. The dose ranges from 5 to 20 c.c., according to the amount of cerebrospinal fluid removed (the amount injected should be less), and the procedure repeated daily according to the severity of the patient's symptoms, until several doses are given. The value of this procedure is still doubtful. Meltzer² has advised the intraspinal injection of 2 c.c. of a 1 : 1000 adrenalin solution every four to six hours. At the time of the first injection the spinal fluid should be withdrawn freely; at subsequent injections, unless the pressure is high, he advises that little if any fluid be withdrawn, and the adrenalin solution washed in with 2 c.c. or more (if no fluid is withdrawn) of normal salt solution. If encephalic symptoms are present the amount of adrenalin solution should be less than 2 c.c. These injections should be continued for four or five days after improvement in the paralysis has ceased. He also thinks that the inhalation of oxygen under pressure for twenty to thirty minutes every two or three hours may be of service. This is especially so when there is evidence of respiratory failure, when it should be administered "under pressure in a respiratory rhythm," combined with artificial respiration if necessary. For this purpose his apparatus should be used. During the acute stage a brisk calomel purge, followed by a saline, is of benefit; and it is necessary to support the general condition. For this reason absolute rest should be enjoined; the diet should be liquid and nourishing, and stimulants should be given freely if necessary. Hexamethylenamin probably exerts an influence in destroying the disease germ. The affected parts must be kept warm by means of cotton wool or extra clothing or artificial heat. As soon as possible the child is to be taken into the fresh air. It is of vital importance to keep up the general systemic tone, and hence the necessity for fresh air, change of scene, and for nourishing but easily digestible food. After the acute symptoms have subsided, massage and electricity should be employed, and the patient encouraged to try to use the affected muscles, together with the administration of strychnin. Care must be taken to prevent their overstretching. To do this or when deformity threatens mechanical appliances may be necessary. In suitable cases either nerve anastomoses or the transplantation of tendons have given good results.

CHRONIC POLIOMYELITIS IN ADULTS

That **chronic poliomyelitis** exists has been proved by Oppenheim and other observers. The symptoms resemble very much those of progressive spinal muscular atrophy (p. 1104). In this affection, however, the intrinsic muscles of the hands are usually first affected, while in chronic poliomyelitis any group may be the first to suffer.

Treatment.—Mercury or the iodids may be tried, especially if there is a history of syphilis. Electricity and massage are of the greatest value.

¹ Neustaedter and Banzhaf (*Jour. Amer. Med. Assoc.*, May 26, 1917, 1531) have had promising results with horse serum.

² *New York Med. Jour.*, August 19, 1916, p. 337.

ACUTE POSTERIOR POLIOMYELITIS

(Herpes Zoster)

The posterior root ganglia of the spinal nerves, and those found in connection with the sensory cranial nerves, are also subject to inflammation due to some infective agent. The symptoms are neuralgic pain in the course of the affected nerves, possibly anesthesia in their distribution, and herpetic eruptions. Constitutional symptoms may also be present. Herpes zoster is a type of this disease. (See also p. 1061.)

While most cases recover, it may be a serious condition. Sight may be lost if the vesicles involve the eye, and unsightly scarring is not unusual.

The treatment consists in protecting the vesicles from rupture and infection by anodyne powders or salves covered with a dressing. Anodynes internally if the pain is severe. Drugs seem to have no effect in shortening the disease, but the salicylates, quinin, and general tonics may be tried.

ACUTE ASCENDING PARALYSIS

(Landry's Paralysis)

Definition.—An acute paralysis, beginning in the legs and ascending by way of the trunk and upper extremities, and ultimately involving the *bulbar* centers. It usually runs a short course, and, as a rule, terminates in death.

Pathology.—Although in many cases neither gross nor microscopic lesions have been found either in the cells, peripheral fibers, or muscles, a number of different anatomic changes have been found in cases believed to have this disease, viz., multiple neuritis, acute diffuse myelitis, and poliomyelitis. A fluid exudation in the central canal of the cord and hyaline change in the central arteries have also been found. The symptoms are evidently due to a severe type of infection involving the peripheral motor neuron, which when very malignant causes death before visible changes occur, while in less acute cases the characteristic evidences of neuritis, myelitis, or both may be discovered.

Etiology.—No definite cause is known. It has followed cold and exposure, traumatism, and the infectious fevers, including influenza. It occurs in males chiefly between twenty and forty years.

Symptoms.—In the most acute cases there are practically no prodromal symptoms other than malaise and possibly chilly sensations. Weakness, followed in a few hours or a day or two by paralysis, develops in the lower extremities. One may be involved a few hours earlier than the other. It spreads toward, and soon involves, the trunk also, and in quick succession the arms. The third and usually fatal stage is reached when bulbar symptoms develop. Very rarely the upper extremities may be first attacked. Death may occur in forty-eight hours. The paralysis is a flaccid one; the muscles can be passively moved without offering any resistance. Wasting rarely occurs and there are no electric changes. In less acute cases a decided febrile stage precedes the onset of paralysis, chills, fever, malaise, and possibly formication or even sharp pain. In any case the later symptoms are pre-eminently or solely motor. Sensory symptoms when present are very slight. The deep reflexes are absent. The bladder and rectum are not implicated nor do bed-sores develop. As stated, when the bulb is attacked death generally follows, due to cardiac or respiratory failure or to interference with deglutition. There are no cerebral symptoms.

Course.—Death may occur in from forty-eight hours to a few weeks. A few cases of recovery have been reported (Sinkler) in some of which paralysis had been wide-spread, even reaching the bulb, judging from the labored respiration. When improvement takes place, it does so in the reverse order to the onset, so that the last part affected is the first to recover. It is much slower than the invasion.

Diagnosis.—The rapid onset of a paralysis that usually ascends, the relaxation of the muscles, slight wasting, if any, and the absence of electric changes and of sensory symptoms, with or without fever, serve to make the diagnosis and to distinguish Landry's disease from ordinary types of poliomyelitis (p. 1089), neuritis, and spinal hemorrhage. For the differential diagnosis between Landry's paralysis and acute myelitis, see page 1095.

Prognosis.—Always grave, particularly if bulbar symptoms occur, and especially if they appear early.

The treatment is essentially the same as that for any acute disease of the cord or nerves—*i. e.*, rest, freedom from all excitement or worry, warm baths and packs, moderate purgation, and diaphoresis; hexamethylenamin, ergot, belladonna, salicylates, and iodids internally. Should the patient survive, electricity and massage should be employed.

ACUTE MYELITIS

(*Myelitis; Acute Diffuse Myelitis; Transverse Myelitis; Myelomalacia*)

Definition and Varieties.—An inflammation, with softening of the cord, giving rise to various groups of symptoms depending upon the region or regions involved, and not, therefore, as constant in its symptomatology as the systemic nervous diseases (tabes dorsalis, lateral sclerosis). It may be acute, subacute, or chronic. If the gray matter only is involved, it is termed *poliomyelitis* (p. 1088); if a small vertical extent (several segments) of both white and gray matter, *transverse myelitis*; if an extensive area of both white and gray matter, *diffuse myelitis*; if a large area of gray matter, *central myelitis*; if in scattered areas, *disseminated myelitis*. If it follows a previous hemorrhage, *hemorrhagic myelitis*, and if it is caused by pressure, as a tumor or bone disease, *compression myelitis*.

Etiology.—Myelitis may follow exposure (especially in alcoholics), the infectious fevers, tonsillitis, and it may be due to traumatism or disease of the vertebræ (caries, malignant disease). It has followed the employment of the Pasteur treatment for rabies. Syphilis precedes it in nearly one-half of all cases. It has also been described as following peripheral neuritis, ascending neuritis, and we meet with some cases in which pregnancy seems to act as the predisposing cause. As the virus causing poliomyelitis may sometimes affect the white matter, this disease may simulate transverse or diffuse myelitis. In many of the cases occurring in those who have arterial disease the cause is thrombosis in a spinal artery, causing softening. This is known as *myelomalacia*. It may be difficult clinically to distinguish it from true myelitis. Myelitis is most common in males, generally from fifteen to thirty years of age.

Pathology.—The cord may present little or no change to the naked eye, or in the most acute cases it may be diffuent. Between these extremes many grades exist in which the pia will be found congested and adherent, the cord being more or less injected, and areas softening and even cavities being found. Three forms of softening: red, yellow,

and gray—depending upon the predominance of blood, fat, or connective tissue respectively. The *postmortem* finding depends upon the duration of the disease; the more chronic the course, the greater the amount of nervous connective tissue (neuroglia), and in consequence sclerosis will be the predominant feature. The nerve-cells and fibers are found in various stages of disintegration, the former being swollen, vacuolated, granular, and their processes broken and in many cases missing; while the latter swell, the myelin breaks up, undergoes fatty change, and is removed, and the axis-cylinders finally break up and disappear. A single area of degeneration may exist centrally, in one-half of the cord, transversely, or many localized or widely disseminated areas may be found; but above and below all of them will be found degenerated fibers—ascending and descending degeneration—due to a solution of continuity between the cell body and its axis-cylinder process. Transverse myelitis, when the extent of several segments of the cord is affected, is the most common.

Symptoms.—These will vary according to the seat and extent of the lesion. In the most acute form the course of the disease is quite rapid, reminding one of hemorrhage into the cord or membranes; the onset, however, is not so explosive, and, though rapid, it is not sudden. There may be chills and fever, malaise, backache, pains in the limbs, or the first symptoms may be numbness of the limbs. In some cases, however, there is no warning. Motor weakness develops, and is rapidly followed by paralysis. Some irritative sensory symptoms appear, as hyperesthesia and paresthesia, and then more or less complete anesthesia supervenes. There is first retention followed by incontinence of urine and feces, and bed-sores and cystitis develop with rapidity. There is usually more or less fever.

Acute transverse myelitis is the type most frequently met with, the lesion being generally situated in the dorsal cord. The motor symptoms generally appear before the sensory symptoms, though they may be contemporaneous. In any event, they are apt at first to be irritative. The limbs will feel tired and heavy and drag in walking, and tremors or twitching occur, even cramps, and later paralysis, partial or complete, in the region involved. The lower limbs alone may be involved, or when the lesion is in the cervical region paralysis and atrophy of the upper with a spastic condition of the lower extremities may develop. The breathing is generally diaphragmatic in cases in which the intercostal muscles are involved. If the lesion is still higher up, death will quickly take place from failure of respiration. Such cases, however, are more apt to occur in the type known as *disseminated myelitis*, in which bulbar symptoms are prone to appear. The sensory symptoms at first are those of a tingling or burning character, or formication. Later, certain or all forms of sensation may be lost, and, roughly speaking, the upper level of anesthesia corresponds to the level of the cord involved. This “boundary region” is apt to be hyperesthetic, and in it the “girdle-feeling” is experienced. The reflexes are usually lost at first; they may remain permanently absent or they may return, and become exaggerated below the lesion. The condition of the tendon reflexes may enable one to locate the position of the cord-lesion, they being lost in parts supplied by the affected segments, but increased below the seat of the lesion. Whether or not there is wasting of the muscles depends on the location of the lesion; if in the dorsal cord, as is usually the case, none will be found. When the cervical region is involved, the muscles supplied by the segments involved will atrophy and the reaction of degeneration will develop. The same thing occurs if in the lumbar cord (p. 1031). Below the seat of the lesion there is paralysis, but no atrophy. Loss of control of the bowel and bladder may be among the earliest symptoms, though this is not the rule. While superficial

ulceration may occur in any neglected case, the most marked trophic changes take place in those in which the lumbar cord is involved, either directly or by extension. In such cases, despite the most assiduous attention, extensive bed-sores develop. The course of the disease depends on the cause and extent of the lesions. Death may occur in a few weeks from exhaustion, heart or respiratory failure, or from kidney diseases secondary to cystitis. Recovery is the rule, though with more or less permanent damage due to degeneration of some of the paths of conduction.

Diagnosis.—The distinction from hemorrhage into the cord or membranes has already been mentioned (p. 1084). From Landry's paralysis it can be separated by a reference to the subjoined table:

ACUTE MYELITIS	LANDRY'S DISEASE
Paralysis is sudden and generally becomes complete.	Paralysis begins in the feet and rapidly spreads to the muscles of respiration and deglutition.
Wasting and bed-sores are marked.	Trophic disturbances are absent.
If atrophy occurs, reaction of degeneration is present.	No reactions of degeneration.
Early involvement of the sphincters.	Bladder and rectum are not involved.
Girdle-pains sometimes mark the height of the lesion.	Girdle-pains are absent.
Sensory paralysis.	No loss of sensation.

Anterior poliomyelitis is not accompanied by sensory paralysis. Bed-sores and disturbances of the sphincters do not occur. In *peripheral neuritis* pain of a shooting character and tenderness over the affected nerves is present, and is almost invariably the first symptom to appear. Motor symptoms may not appear for some days. This is not the case in myelitis. In *compression of the cord* sufficient collateral evidence, as evidence of bone disease, can usually be obtained to differentiate it from myelitis. *Hysterical paraplegia* is occasionally misleading. The character of the patient and the previous history should be thoroughly considered; moreover, in this form there are no trophic changes, and, as a rule, no bladder symptoms; at any rate, there is no cystitis. Retention of urine may occur, but not incontinence, and the Babinski reflex is absent. The diagnosis of myelitis can usually be made without great difficulty from the motor and sensory symptoms, the vesical, rectal, and trophic symptoms, and often from the presence of the girdle sensation in addition. Myelomalacia can usually not be distinguished clinically from myelitis. The symptoms occurring in an old person, without any of the causes of the latter having been operative and the existence of a previous history of syphilis, is rather in favor of the former.

Prognosis.—The most acute cases are fatal in from three days to a week. Less acute cases generally recover with more or less loss of motor power. Improvement may continue for several years.

Treatment.—Very little can be done to arrest the process in acute myelitis. Absolute rest should be enjoined, and the patient given a nutritious liquid diet with free stimulation. The patient should be placed on an air- or water-bed. Trophic changes should be looked for daily, and at the first sign of their appearance alcohol or some stimulating liniment should be employed. If the skin is broken, absolute cleanliness must be observed, and the wounds dressed antiseptically. It is well, also, to change the patient's position from time to time to avoid too long-continued pressure in any one spot. The bladder must be watched to see that retention does not occur (p. 1029), and if cystitis develops it should be treated by the usual methods employed for that condition. Either the salicylates or hexamethylenamin should be given in infectious cases

and in specific cases arsphenamine, mercury, and potassium iodid in full doses. A general tonic and supportive treatment is indicated, and later massage, electricity, and baths.

CHRONIC MYELITIS

That there are both a subacute and a chronic form of myelitis is generally conceded, though these types are not sharply circumscribed.

Etiology.—This is not clearly known; an acute attack may terminate and the tissue of the cord become sclerosed with persistence of the symptoms; or the disease may commence insidiously as the result of the existence of some chronic infectious process, such as syphilis; it may be the sequel of an acute infection, such as typhoid fever, or follow a fall or blow upon the back. The primary form is rare.

Pathology.—Histologically, the chief differences from the acute variety consist in the greater amount of sclerosis, the thickened blood-vessels with contracted lumen, and an entire absence of recent hemorrhage. In some cases also the pia is much thickened in patches and firmly adherent. The nerve-cells are either seen to be in advanced stages of degeneration or they have actually disappeared. Secondary degenerations, above and below, proceed from the primary foci.

Symptoms.—Any symptom occurring in the acute may be duplicated in the chronic form, though the onset of the latter is gradual. The symptoms are more or less obtrusive, according to the region of the cord that is affected, and it may be several years before they are fully developed. In those cases which do not follow the acute, the first symptoms complained of are usually numbness of the legs and a feeling of weakness, which gradually progresses until in some cases they may become useless. If the meninges are involved, as they frequently are (meningomyelitis), shooting pains in the extremities and a girdle sensation are complained of. The symptoms differ somewhat, according to the nature of the lesion. This is usually of the transverse variety, which, if in the dorsal region, as it usually is, causes a spastic paraplegia, with increased deep reflexes, Babinski reflex, some sphincter disturbance, and more or less complete loss of sensation to the level of the affected segments. If in the cervical enlargement, which is rare, more or less atrophic paralysis of the arms, owing to the involvement of the gray matter, with a spastic paralysis of the legs and loss of sensation to the affected segments, will be present. If in the lumbar region, the symptoms will differ somewhat, according to the segments involved. There will, however, be atrophy in certain muscles and spasticity and absence of atrophy in others (p. 1031). Owing to involvement of the posterior columns there may be more or less ataxia, so that the gait is a mixture of a spastic and ataxic type (ataxic paraplegia). The disseminated type resembles multiple sclerosis.

Diagnosis.—The gradual, and in many cases the irregular, onset characterize this disease. In its various phases it may simulate almost any spinal cord disease, and it is most apt to be confounded with tumor pressure (carius or malignant), primary lateral sclerosis, amyotrophic lateral sclerosis, and syringomyelia. *Pressure*, whether due to a tumor, to vertebral caries, or to malignant disease, is apt to cause pain radiating in character, and the last two usually present collateral evidences in the deformity and cachexia (p. 1097). The symptoms, too, in the case of tumor may, at first, be unilateral and confined principally to the muscles and skin areas supplied by the affected segments

(p. 1031). Amyotrophic lateral sclerosis is distinguished by the fibrillary tremors in the atrophied muscles, absence of sphincter involvement, and sensory symptoms. Syringomyelia is characterized by the loss of pain and temperature sense with preservation of tactile sense in certain areas.

The **prognosis** is necessarily grave. Recovery may be possible, but it is extremely rare. The process, however, may be arrested and the patient live for years, more or less helpless.

Treatment.—More can be expected from general hygienic measures than from the use of drugs. In the early stages rest is indicated, but it is well also to employ passive exercise to prevent, if possible, a too great contraction of the muscles. As soon as expedient—each case being judged on its merits—the patient should be taken out of doors. Change of air and of scene is advisable, as are also baths and massage. Mild counterirritation may be applied to the spine, but care should be taken to avoid the areas of anesthesia. General tonics—iron, quinin, arsenic, and strychnin—should be given, also mercury and the iodids. The greatest possible care of the bladder should be taken in order to avoid cystitis. Good results have been obtained by Bailey and Elsberg¹ from the performance of what they term “spinal decompression.” This consists in opening the spinal dura over the seat of the lesion and then closing the wound in the usual manner.

COMPRESSION OF THE SPINAL CORD

(*Compression Myelitis*)

It is of importance to be able to recognize this condition. To be sure, it is not always possible to diagnose it with certainty, but when there is a reasonable surety the question of operation may arise.

Etiology.—We may classify the causes of compression under three headings—(a) traumatism (fracture), (b) inflammatory disease (caries of the spine, due to tuberculosis or syphilis), and (c) neoplasms (including various tumors, gummata, and aneurysm); but these will receive separate consideration (*infra*); (d) dilatation and varicosity of the posterior spinal veins.

Pathology.—The postmortem findings will depend upon the degree and duration of the pressure. More or less meningitis is often associated, especially in the cases due to vertebral caries. The cord will be more or less flattened and distorted at the seat of pressure, and in the early stages hyperemic and possibly softened. Later it is hard, sclerosed, and of a grayish color, and above and below the compressed region degenerated areas will be seen on sectioning the cord. Microscopic examination reveals various stages of degeneration of the nerve elements at the point of pressure and secondary degeneration of the various tracts. The nerve-roots will be more or less damaged by compression.

Symptoms.—These will vary according to the site of the lesion and the extent of involvement—*i. e.*, the vertical extent, the degree of pressure exerted, and the amount of inflammation present. Two groups of symptoms are present in typical cases—first, those due to involvement of the nerve-roots, and, second, those dependent upon involvement of the cord itself—*ascending* and *descending* degeneration. Pressure upon the *posterior roots* gives rise to *pain*, neuralgic in character and radiating along the course of the nerves. There may be *paresthesia* and *formication*. These irritative symptoms are followed sooner or later by destructive changes, and hence the anesthesia. There may be spontaneous pain in the anesthetic areas (*anesthesia dolorosa*), which areas are of

¹ *Jour. Amer. Med. Assoc.*, March 9, 1912, p. 675, and *Jour. Nerv. and Ment. Dis.*, October 1916, p. 339.

the segmental type and depend in location upon the cord segment and corresponding nerve-roots involved (Fig. 76). Pressure upon the *anterior roots* also causes irritative and paralytic symptoms, and hence the early twitching, or even spastic condition, and later the loss of power or paralysis. The muscles supplied by nerves from the affected segments waste, and qualitative and quantitative electric changes can be elicited.

The *second group* of symptoms, due to secondary degenerations, then develops, and may set in either rapidly or slowly. If myelitis promptly supervenes and is extensive, *cord symptoms* of a pronounced type develop quickly. The parts below the lesion will become weak, there will be girdle pains, and a sense of constriction or pain in the legs. Sensory paralysis is usually not so marked in this region as the motor, as the sensory tracts are less vulnerable to pressure than the motor, but hyperesthesia and hyperalgesia are present in most cases. They may, however, be absent. The reflexes, whether increased or absent, depend upon the location of the lesion (p. 1027). As the dorsal region is most commonly involved the deep reflexes of the lower limbs are increased. The Brown-Séquard syndrome may be present (p. 1034). If the cause of compression ceases to act for some time, some improvement takes place, due possibly to the subsidence of the myelitis. If the pressure is of *slow onset*, great tolerance is manifested. Usually sensation is recovered before motion. In certain cases, however, motor power is regained, while the muscular and tactile senses do not return. In such instances, in which the posterior columns bear the brunt of the trouble, inco-ordination results and there is secondary ataxia. If the disease is below the first lumbar vertebra the cauda equina only is affected (p. 1102).

Diagnosis.—If the combined symptoms of peripheral and central origin develop slowly in the order named, compression is likely. It has been asserted¹ that when the paralysis is due to pressure, actual degenerative changes not yet having taken place, that the tendon reflexes are not increased but the skin reflexes (plantar) are very much so. *Myelitis* gives rise first to cord, and only later to root symptoms; hence the difficulty in cases in which myelitis develops quickly. Extensive root-symptoms are suggestive of *meningeal involvement*. In any event, too much stress should not be placed on the nervous symptoms alone. The spine should be carefully examined and palpated for points of tenderness. Careful note should also be taken as to whether there is any limitation of movement or deformity (kyphosis). The family history may suggest *tuberculosis* (caries of the spine). A skiagraph of the spine is often valuable, as it must be borne in mind that Pott's disease may occur without spinal deformity. The cerebrospinal fluid may present peculiar changes (p. 1100). Tumor is discussed on p. 1099. The history will indicate if due to vertebral fracture.

The **prognosis** depends entirely upon the cause. Having ascertained this, it then depends upon the possibility of its removal.

Treatment.—In general, the treatment is that of myelitis. When due to tubercular disease of the vertebra, the treatment indicated is for that condition, and a surgeon should be consulted, though operative cases are the exception rather than the rule. It is well to impress upon the patient and relatives the chronicity of the condition, but faithful and persistent efforts will yield good results. Rest is of vital importance, particularly when the disease is active. The patient should be kept in bed in a recumbent position until consolidation has taken place. Extension may be necessary. Good and easily assimilable food and cod-liver oil and alteratives should be given. The nutrition of the muscles may be improved by general friction (massage). As

¹ *Jour. Amer. Med. Assoc.*, January 25, 1913, p. 269.

soon as possible a plaster jacket should be put on the patient, and he should be taken into the open air and sunlight. If a history of syphilis is obtained, that condition should be vigorously treated. In vertebral fracture the question of operation to remove the fragments of bone pressing on the cord may arise. In most cases laminectomy is advisable after shock has passed away, unless there is positive evidence that the cord is completely divided. The seat of the lesion must be determined by the methods detailed on pp. 1027-1034. When due to tumor, see page 1101.

TUMORS OF THE SPINAL CORD AND ITS MEMBRANES

Under this heading are included the granulomata, parasitic cysts, and those due to other causes, as circumscribed spinal serous meningitis as well as neoplasms proper. The classification of Bruns is a convenient one:

I. Tumors which, arising in its envelopes, secondarily affect the spinal cord.

(a) Vertebral tumors arising from the spinal column or the soft tissues immediately surrounding it.

(b) Intravertebral tumors, which may be divided into two classes, in accordance with their relation to the dura mater.

1. Extradural tumors originating in the periosteum of the vertebra, the outer layer of the dura mater, or the fatty areolar tissue of the epidural space. Those arising from the vertebra are frequently malignant, either carcinoma or sarcoma, and are usually metastatic. Myelomata also occur. Benign growths, as osteomata, exostoses, chondromata, etc., are rare.

Extradural growths comprise sarcomata, lipiomas, fibromata, myxomata, and chondromata. The first two are the most common.

2. Intradural tumors originating from the inner layers of the dura, the arachnoid, the ligamentum denticulatum, the spinal roots, or the pia mater.

Intradural tumors may be either diffuse or localized. Sarcomata, which may or may not be metastatic; endotheliomata, cylindromata, fibromata, and lymphangiomata. Fibromyxomata and fibrosarcomata are frequently found in connection with the nerve-roots. Cysts are also found within the dura. Intradural growths are usually found in the lateral or posterolateral surfaces of the cord, a fact which facilitates their removal.

II. Intramedullary tumors of intrinsic spinal origin.

Intramedullary neoplasms comprise gliomata, sarcomata, angiosarcomata, gummata, and tubercles. Gliomata usually give rise to the symptom complex known as syringomyelia (p. 1110), but may be circumscribed.

Etiology.—As has been said, malignant and tubercular growths are often secondary to similar conditions elsewhere. Trauma seems to be a cause in some cases, especially non-parasitic cysts. They most frequently occur after middle life (forty to sixty). Extramedullary growths are more common than intramedullary. The former occur most frequently in the dorsal region; the latter in either the cervical or lumbar enlargement.

The **symptoms** of extramedullary growths are due to irritation of nerve-roots, especially the posterior and compression of the cord (p. 1097). There are, therefore, pain in course of the roots arising from the affected region and a gradually developing paraplegia. If the anterior roots of either enlargement

are affected, clonic spasms may occur. The pain is usually shooting in character, but in between the paroxysms it may be constant. Hyperesthesia may also be present in the skin area supplied by the affected nerves. According to Starr, the order in which the symptoms arise is commonly: (1) Peculiar pains of limited distribution; (2) increase of reflexes below the lesion; (3) paraplegia; (4) loss of sensibility; (5) loss of subjacent reflexes. The pain, as well as evidences of compression, may at first be unilateral and the Brown-Séquard syndrome (p. 1034) may be present. As the growth enlarges they become bilateral. In some cases ataxic symptoms with increased reflexes may be more prominent than paralysis. Segmental areas of anesthesia usually soon develop.

The symptoms of intramedullary tumors depend on their location; if within the gray matter, the symptoms are those of syringomyelia (p. 1110), otherwise they resemble those of a slowly developing myelitis, motion being lost before sensation. Pain is not apt to be a prominent symptom until the periphery is reached. The Brown-Séquard syndrome frequently occurs. The functions of the different segments of the cord are given on page 1031. Interference with these functions points to the particular part of the cord involved.

Circumscribed spinal serous meningitis causes symptoms so much resembling tumor that it may be mentioned here. The dura is usually found very tense and bluish in color, but no macroscopic lesion is found. When opened the fluid escapes under marked pressure. The symptoms are usually sensory, especially intense pain of a segmental distribution first appearing before other symptoms develop, which are those of pressure, as in tumor. A peculiarity is that the symptoms are apt to vary from time to time, according as the pressure of the fluid increases or diminishes.

Course.—Tumors usually grow slowly, and therefore the symptoms are gradual in their development. Ordinarily there are periods of arrest or even improvement that are followed subsequently by further advance. The *duration* of spinal tumors is variable. Those of malignant nature or rapid growth may produce death in a short time; those that simply exert pressure and enlarge very slowly may not produce total disability for several years. In general, it may be said that from five to ten years is the ordinary limit after the first appearance of motor disturbance. Some tumors, however, particularly lipomata, produce only slight disturbances throughout life, or else no symptoms at all, remaining entirely latent.

The **diagnosis** involves three points: first, the recognition of the presence of the tumor; second, of its site; and third, of its nature. The prodromal symptoms of spinal tumor are often confounded with *neuralgia* or *lumbago*. It is sometimes possible to make a **differential diagnosis** by means of the presence, in neuralgic conditions, especially of intercostal nature, of the sensitive points along the course of the ribs, and of the existence, in the case of tumor, of exaggerated knee-jerks and sensitiveness over certain portions of the vertebral column. In the paraplegic condition it may be confounded with a *neuritis*, but in this there is tenderness over the nerve-trunks, absence of reflexes in the paralyzed parts. Sensory paralysis, if it exists, is not confined to the distribution of individual nerves, but is of the segmental type (Fig. 76), and the sphincters are not disturbed. The cerebrospinal fluid may present peculiar changes in compression of the spinal cord by tumor or otherwise. These are a great increase in the protein content, a yellow color of the fluid, and sometimes coagulation of it. The cells are not increased unless meningeal irritation is present. These changes if present are characteristic. Lesions of the cauda equina may be difficult to differentiate (p. 1102).

The *intrinsic diseases* of the spinal canal give rise to much greater difficulty, especially *myelitis* and *pachymeningitis cervicalis*. From the former the correct diagnosis may sometimes be suspected, because in tumor there are severe radiating pains and the symptoms are more pronounced on one side than on the other, and are apt to be more gradual in their development. Moreover, the symptoms of segmentary involvement are sharper and the root symptoms more characteristic. From *pachymeningitis cervicalis* a tumor in the cervical region can be usually distinguished by the fact that the radiating pains are less severe and the symptoms not so distinctly bilateral. It may be impossible to distinguish a central tumor from *syringomyelia* unless the symptoms of root pressure are quite distinct. *Pott's disease*, in its early stage, may also give rise to some difficulty. However, the rapid development of the kyphosis, and particularly the pain that is elicited by sudden pressure upon the head, renders it possible, after a reasonable period of observation, to recognize the true nature of the case (p. 1097).

The *diagnosis of the position of the tumor* has been largely discussed in the Symptomatology. In general, this is determined by determining the existence of symptoms dependent upon interference with the functions of certain segments of the cord (p. 1031, Fig. 76) plus disturbance of the functions of tracts of the cord, causing symptoms in parts innervated by the segments below those affected (*vide* Compression of Spinal Cord). The symptom-complex may, however, be considerably disturbed by the presence of multiple tumors. In these cases the majority ordinarily remain latent. It may also be said that the presence of root pains suggests a meningeal seat, while pronounced paraplegia, dissociation of sensation, or the Brown-Séquard symptom-complex points to the presence of a tumor in the substance of the cord itself. (See table on p. 1031).

Finally, the recognition of the *nature of the growth* can often be made from the history of the existence of the tumor or an infectious process in other parts of the body; the rapidity of the growth; the age of the patient; and occasionally from the results of an exploratory operation. It must be remembered, however, that it does not always follow that a tumor in the spinal canal is similar to that found elsewhere.

The **prognosis** depends upon the severity of the symptoms, the rapidity of their development, and the nature of the growth, if this should be known. Complete subsidence of all the symptoms may occur, even after a spastic paraplegia has existed. Of course this is only likely in those cases in which the tumor can be removed by operation or absorbed through the action of drugs.

The **treatment** depends wholly upon the recognition of the nature of the tumor; if this be syphilitic, arsphenamine, mercury, and potassium iodid should be given in full doses. If, on the other hand, it is not specific, and especially if extradural, operation would seem to offer a possibility of cure. This has been done successfully a number of times. Intramedullary growths may also be removed. In such cases a two-stage operation is necessary, allowing the tumor to extrude itself after the cord has been exposed.¹ Early operation in cases of circumscribed spinal serous meningitis has given most excellent results. As the prognosis is, in general, unfavorable as to cure and often gloomy as to life, the clinician should not hesitate to recommend surgical interference. When the tumor is known to be malignant, the pain may be relieved by cutting the anterolateral columns of the cord.

¹ *Jour. Nerv. and Ment. Dis.*, August, 1916, p. 97.

LESIONS OF THE CONUS MEDULLARIS, EPICONUS, AND THE CAUDA EQUINA

As symptoms produced by lesions of these regions frequently resemble each other, they are described together.

The conus medullaris comprises that portion of the cord extending from the filum terminale to and including the third sacral segment. Lesions in this region are characterized by the absence of paralysis of the limbs and by paralysis of the sphincters of the bladder and rectum with loss of sexual power. There is also a saddle-shaped area of anesthesia involving the skin about the anus, perineum, posterior part of the scrotum, penis, and the mucous membrane of the urethra and anus. The testicle is sensitive, its nerve supply originating higher up (Fig. 76, p. 1031).

That part of the cord comprised between the fourth and fifth lumbar, as the upper and the second and third sacral segments as the lower limit, is known as the *epiconus*. A lesion here causes loss of Achilles' jerks, preservation of knee-jerks, intact sphincters, motor paralysis, most marked in the peroneal muscles, with atrophy and reactions of degeneration and a steppage gait. Sensory paralysis will be found in the distribution of the affected segments (Fig. 76).

As the spinal cord terminates at the second lumbar vertebra, tumors or injuries below this point produce symptoms only in so far as they compress or destroy the lumbar and sacral roots (cauda equina). This destruction may be partial or complete. If partial, there are *paralyses* of various groups of muscles and circumscribed areas of anesthesia, with radiating pain in the course of the affected roots. This, especially in the sciatic nerves, may precede by a considerable period the development of other symptoms. There may or may not be a disturbance of the functions of the bladder and sphincters. If all of the nerve-roots are involved, there are complete anesthesia, complete paraplegia, flaccid in character, with reactions of degeneration in the muscles, loss of the knee-jerk and Achilles' jerk, absence of the Babinski jerk, and rectal and vesical incontinence. In some cases there may be isolated paralysis of the bladder and rectum. These lesions may consist of tumors, such as are found in the membranes of the cord or on the nerve-roots, and it should be noted that, probably on account of greater space for their development, tumors in this situation are apt to be larger than those in other parts of the spinal canal. They may also consist of fractures or lesions occurring as a result of congenital anomalies, such as spina bifida. If fracture and dislocation of the vertebræ are present the diagnosis between a lesion involving the lower part of the cord and one involving the cauda equina is easily made, as in the latter case the location could be below the first lumbar vertebra. If due to hemorrhage or tumor it may be more difficult. If due to the former the symptoms would likely develop more gradually than when the spinal cord is affected (p. 1084). Shooting pains in the course of any of the nerves arising in the sacral segments, pain preceding for some time the development of other symptoms, and an irregular development of the motor symptoms are in favor of a lesion involving the cauda equina. If tumor is suspected, the treatment is similar to that of spinal tumors (p. 1101). In conus lesions the incontinence of urine may be relieved by anastomosing the first lumbar and third and fourth sacral roots.¹

¹ Frazier and Mills, *Jour. Amer. Med. Assoc.*, December 21, 1912, p. 2202.

PRIMARY LATERAL SCLEROSIS

By this is meant a primary degeneration of the central motor neurons. It is a system disease (p. 1034) affecting the central motor neuron and is a rare condition, most cases so called being due to a secondary degeneration caused by a lesion cutting the tracts somewhere. A few cases have been reported in which no such lesion could be found. The *hereditary type*¹ is probably the most common. The only pathologic change observed is in the pyramidal tracts of the anterior and lateral regions.

Etiology.—It is most apt to occur when there is a *neuropathic family tendency* or congenital weakness. *Age*, generally between twenty-five and are all predisposing causes. *Syphilis* may cause the condition. Most cases presenting this symptom-complex are due to a secondary degeneration of the pyramidal tracts, caused by some lesion, as a mild myelitis, higher up. Vertebral disease may also cause similar symptoms. A number of cases have been reported occurring in a number of generations of a family (*hereditary spastic spinal paralysis*). In these cases the symptoms may appear in childhood and atrophy of the optic nerves may be associated (pp. 1104, 1108, 1123, 1140).

Symptoms.—In typical cases the onset is slow. The patient complains of feeling tired, and is less capable of exertion than formerly. Weakness of the legs develops, and with it increasing difficulty in walking. Even at an early stage some rigidity of the muscles will be present when the limb is extended; later this becomes a prominent symptom. The spasm is at first of little moment. It may only be noticed in the morning. When the disease has advanced, however, it becomes pronounced, so that it may not be possible to flex the limb, or, if flexed and an effort is made to extend it, it will often spring forward like a knife-blade in clasp-like rapidity. This spasticity is often so marked that in walking, so long as the ball of the foot touches the ground, clonic contractions occur; these also appear when the individual is in a sitting posture unless his legs are extended. The gait is characteristic; the legs are stiff, and move with an evident effort, while the toes scrape the ground. In some cases the adductor spasm is so great that the legs not only cannot be separated, but are actually overlapped in walking (*cross-leg progression*). In course of time the power of walking may be lost. The flexor muscles are usually weakened. The knee-jerk is very much exaggerated, a mere tap causing a sharp, quick response. Ankle-clonus can always be elicited. The Babinski reflex is present. Pains and other sensory manifestations are often absent, though dull and fleeting pains in the back and limbs may be complained of. The arms are frequently unaffected. The sphincters are rarely involved, and ocular symptoms do not occur. Seguin states that the ability to retain the urine is lessened and precipitate micturition results.

The **diagnosis** is not difficult. Certain hysteric cases may occasionally simulate it very closely, but these do not present the characteristic spasticity of the true form, nor the knee-jerk increased quite as much, ankle-clonus is either slight or absent, and the Babinski reflex is not present. Then, too, in hysteria spots of anesthesia are commonly met with. In myelitis there is usually more or less sensory paralysis and involvement of the sphincters; if, however, it is very mild in type, the diagnosis is most difficult. The possibility of caries of the vertebræ must be borne in mind when the symptoms are developing (p. 1097). The congenital type, due to cerebral lesions, is described on p. 1123. Hydrocephalus may also be mistaken (p. 1136).

Treatment consists of maintaining the general health, warm baths for the

¹ Rhein, *Jour. Nerv. and Ment. Dis.*, August, 1916, p. 115.

spasticity, and antisyphilitic medication if there is a history of that disease. In the hereditary form benefit has been obtained by tenotomies, followed by electricity. Cutting the posterior nerve-roots may also be considered if spasticity and not weakness is the dominant condition, as may also spinal decompression (p. 1097).

PROGRESSIVE SPINAL MUSCULAR ATROPHY

(*Amyotrophia Spinalis Progressiva*; *Type of Duchenne-Aran*)

Definition.—A system disease (p. 1034) of the peripheral motor neurons and the muscles they supply, usually beginning in the cervical region.

Pathology.—There is atrophy of the anterior cornua of the cord, affecting chiefly the ganglion cells, degeneration of the nerve-fibers and of the muscles. Occasionally there are small areas of sclerosis that may involve the pyramidal columns for a short distance.

Etiology.—The disease appears to be hereditary in a few cases, and in these may develop in childhood (Werdnig and Hoffman type). A commonly accepted predisposing cause is prolonged severe muscular exertion. Syphilis may also be a factor. Many cases are probably due to congenital weakness of this part of the nervous system. It is most common in males, and most frequently appears during the third decade of life.

Symptomatology.—The first changes usually appear in the *thenar and hypothenar eminences* of the hands, but may begin in other muscles. These become flat and soft; there are loss of power, some stiffness, and inability to perform delicate coördinated movements; the thumb assumes a position parallel to the other fingers (*ape-hand*); the interossei muscles waste and grooves appear between the metacarpal bones. The degenerative changes do not ascend by continuity, the deltoid usually being affected immediately after the muscles of the hand. If the two hands have not been affected simultaneously, the other now begins to show characteristic changes. In the lower limbs the quadriceps femoris is usually the first muscle attacked. The disease gradually involves one group of muscles after another until a large part of the muscular system is affected. All the affected muscles exhibit the fibrillary twitchings and the wasting. Hypertrophy never occurs and the *paralysis* is always flaccid. The fibrillary twitchings are characteristic, but not pathognomonic. They are not always constant, but may be developed by slightly irritating the muscle. At first there is usually quantitative diminution of the response to the faradic and galvanic currents, but as the disease progresses the reaction of degeneration becomes completely developed. The *reflexes* diminish in proportion to the atrophy of the muscles, and ultimately disappear completely; the patients gradually become almost incapable of voluntary motion; but for a time they learn to overcome their disabilities by the compensatory use of other groups of muscles. In the late stage the diaphragm becomes paralyzed and bulbar symptoms appear (p. 1087); usually the patients die from inspiration pneumonia. Rare and probably accidental symptoms are disturbances of the pupillary reflexes and increase in the secretion of sweat.

Differential Diagnosis.—In *chronic anteropoliomyelitis* groups of muscles are affected without any particular order, certain groups of muscles becoming paralyzed suddenly, followed by the gradual involvement of other muscles; in *amyotrophic lateral sclerosis* the spastic symptoms are present; in *syringomyelia* and *pachymeningitis cervicalis hypertrophica* disturbance of sen-

sation, pain, and trophic lesions occur; in *Pott's disease* affecting the lower cervical region there are tenderness over the spine and sensory disturbances; in *peripheral neuritis* pain and tenderness over the nerve-trunks are present; in *arthritic atrophy* joint symptoms are present; and in the peculiar *muscle atrophies* following excessive use of certain groups of muscles rapid improvement occurs when the cause is removed and the symptoms are confined to the muscles originally affected (either median or ulnar distribution) (p. 1075). The muscular dystrophies are described on page 1207.

Prognosis.—This is unfavorable as to cure. The course is exceedingly slow, and the patients often live for a number of years after the first symptoms have appeared. They are, however, exceedingly liable to pulmonary complications, particularly a fatal form of bronchitis.

Treatment.—Prophylactic measures, such as the avoidance of prolonged excessive work, are rarely possible. Retardation may possibly be obtained by the systematic use of electricity, massage, and gymnastics. Gowers advocates the hypodermic injection of strychnin nitrate in ascending doses, commencing with $\frac{1}{100}$ gr. and rapidly increasing to $\frac{1}{40}$; one injection should be given daily. The general nutrition should be kept at the highest possible point.

AMYOTROPHIC LATERAL SCLEROSIS

(*Charcot's Disease*)

Definition.—A system disease (p. 1034) of both central and peripheral motor neurons, affecting, therefore, the entire motor tract from the cerebral cortex to the muscles, characterized by loss of power, spastic symptoms, and muscular atrophy. The first clear and thorough description of the clinical symptoms and pathologic anatomy was given by Charcot in 1872.

Etiology.—The disease is more frequent in males and usually begins in early adult life. Exposure has sometimes been noted in the previous history. Many cases are probably due to congenital weakness of the motor tract (abiotrophy). Syphilis may be a cause.

Pathology.—The pyramidal tracts are degenerated, the process commencing either in the cortex, crura, or medulla, and extending to the termination of the neurons in the cord. The ganglion cells of the anterior cornua are atrophic, there is degeneration of the anterior roots and of the muscle-fibers, the blood-vessels in the affected parts are dilated, and in the early stages granular cells are present.

Symptoms.—Three stages are generally recognized: (1) The involvement of the upper extremities. (2) The participation of the lower extremities. (3) The appearance of bulbar symptoms. At first there are weakness of the upper arms, atrophy of the muscles, and moderate exaggeration of the reflexes; in the course of a few months the symptoms of spastic paraplegia develop, all the reflexes are greatly increased, and there are chin- and ankle-clonus, the Babinski reflex, and dragging of the feet. The wasted muscles show fibrillary twitchings and give the reactions of degeneration. Contractures then occur, the forearms are flexed on the arms, the hands are held in pronation, and the proximal phalanges of the fingers bent backward, giving rise to the so-called *claw-hand*. From time to time there are tonic spasms in the muscles, particularly in the calves. Sensation is not disturbed, excepting for the occurrence of occasional slight paresthesia, and the sphincters continue to functionate

normally. Finally, the bulbar symptoms appear, and there is paralysis of the lower part of the face, which becomes rigid and expressionless, with the mouth partly open and saliva dribbling from the angles. Deglutition and articulation become difficult or impossible, and death finally occurs from exhaustion or inspiration pneumonia. Atypical cases occur, in which either the lower extremities are first involved or the paralytic symptoms are more prominent than the spastic symptoms, or the bulbar symptoms appear very early. The symptoms at first may be unilateral (*infra*). The course is steadily progressive, and death usually occurs within a few years.

The **differential diagnosis** is to be made from *multiple sclerosis* by the absence of nystagmus, of the intention-tremor, and of sensory disturbances, and by the degenerative changes in the muscles; from *transverse myelitis* by the absence of sphincter disturbance, sensory paralysis, and of pain; from *progressive spinal muscular atrophy* by the presence of spastic symptoms; from *syringomyelia* by the absence of sensory disturbances, trophic lesions of the skin and joints, and the greater regularity of the course; from *pressure upon the spinal cord* by the absence of pain, sensory paralysis, and sphincter disturbance.

Prognosis.—It will be understood from the foregoing description that death is the invariable termination. The course is progressive, although sometimes very deliberate, and even temporary amelioration rarely occurs.

Treatment.—The patient should be rendered as comfortable as possible, excessive physical exercise avoided, and the general nutrition increased.

UNILATERAL ASCENDING AND UNILATERAL DESCENDING PARALYSIS

Unilateral ascending paralysis, first described as an entity by Mills, is of various pathology and is characterized by paresis commencing in one leg and extending to the arm on the same side. The paresis may be flaccid (Patrick), with loss of the reflexes, or spastic (Mills, Potts, etc.), with increased knee-jerks, ankle-clonus, and the Babinski phenomenon. In time complete paralysis may develop. Degeneration of the motor tract has been found. According to Mills it may be produced: (1) By primary degeneration of the pyramidal tracts, to which may be added other degenerative lesions; (2) as the early stage of multiple sclerosis; (3) as the form assumed by unilateral amyotrophic lateral sclerosis; (4) as the order of progression in unilateral paralysis agitans; (5) as the expression of a focal lesion either cerebral or spinal; (6) as a clinical type in cerebrospinal syphilis; (7) as a peripheral or hysteric affection. The treatment depends upon the cause.

INTERMITTENT PARAPLEGIA

(Intermittent Claudication)

Three forms of this affection have been described, *i. e.*: (1) Those due to an arteritis of the vessels supplying the peripheral nerves; (2) those caused by a spasm of these arteries; (3) those due to similar phenomena occurring in spinal arteries. The symptoms consist of muscular cramps and weakness, usually but not always in one or both legs, occurring after moderate exertion. In the first type there is often loss of pulsation in the posterior tibial and dorsalis pedis arteries, in the third the sphincters are affected and cramps do not occur (p. 1113). The treatment is that of arteriosclerosis.

HEREDITARY ATAXIA

This may be divided into two types, viz.: the spinal type, or Friedreich's disease, and the cerebellar.

FRIEDREICH'S DISEASE

(*Friedreich's Ataxia*)

Definition.—An hereditary disease, first described in 1861 by Friedreich. The symptoms are primarily manifested in early life, and the disease is characterized by ataxia, defective speech, nystagmus, absence of the knee-jerk, and more or less secondary deformity, as spinal curvature or talipes.

Etiology.—Family tendency (heredity) has a strong influence. A single case, however, may develop in a family. It is due to an inherited and inherent lack of vitality in certain parts of the nervous system (abiotrophy).

Age.—Most commonly the disease appears between the third and twelfth years, though it may appear earlier or later.

Infectious fevers (in particular) and other acute diseases frequently precede the evolution of this complaint. Trauma and many other conditions have been described as exciting causes.

Pathology.—The cord frequently is smaller than normal, and at times there is some thickening of the membranes over the posterior aspect. Microscopically are found degeneration of the posterior columns, more marked in the column of Goll, of the crossed and direct pyramidal tracts, the direct cerebellar tract, and that of Gowers. In the columns of Clarke are found atrophy of the cells with loss of fibers. In some cases the posterior roots may also be found degenerated, also the cells in the anterior horns and the peripheral nerves. The cerebellum is frequently smaller than normal, and degeneration of the cells composing the dentate nucleus occurs. The cells of Purkinje are also atrophied in some cases. Changes have also been found in the cerebrum consisting of atrophy of the gyri and changes in the cerebral cortical cells. Atrophy and disappearance of the cells of the posterior root ganglia have also at times been observed. Changes in the muscles similar to those found in the dystrophies (p. 1207) may occur. The degeneration in the posterior columns is more marked usually than in other parts, the pyramidal tracts being next in severity.

Symptoms.—The earliest evidence of the disease is impaired co-ordination, first in the legs, and later in the arms; it is most marked when the eyes are closed. Attention is often called to this symptom by the fact that the child stumbles, ambles and staggers, and cannot walk properly. The gait, however, lacks the pronounced stamp of true ataxia. In many cases the great toes are turned upward. Some affected children never learn to walk. Romberg's symptom is generally present. Movements of the arms, when these are ataxic, are irregular and jerky, and jerky movements of the head may also be observed. Bilateral nystagmus develops and the speech becomes affected. At first there is a mere impediment (a stuttering), but later syllables or even whole words are omitted and an unintelligible jargon results. The knee-jerks are almost always absent. There is no optic atrophy,¹ nor are any sensory symptoms present as a rule. In some cases interference with sensation similar to that found in tabes (p. 1151) may be present. The sphincters are not involved. There are no trophic changes in the skin or the joints and no visceral crises. Vasomotor symptoms—flushing, sweating—are sometimes observed. There is usually no mental change.

¹ See Hereditary Cerebellar Ataxia, p. 1108.

Talipes and spinal curvature are generally met with after the disease has existed for some time. In old cases muscular weakness and wasting are present, but the muscles do not give the reactions of degeneration.

The **course** is always slow. It may last for many years, thirty or even more.

Diagnosis.—Usually this is not difficult, and especially when more than one case exists in a family. The age, inco-ordination, nystagmus, slurring speech, and deformity are strikingly characteristic.

Differential Diagnosis.—In *juvenile tabes dorsalis* the preataxic stage (pain, absent knee-jerk, and ocular symptoms) is generally well marked. It is absent in hereditary ataxia, nor does the latter present the sensory and visceral symptoms met with in the former. The gait is very different and the Argyll Robertson pupillary changes are never present.

Ataxic paraplegia shows an exaggerated knee-jerk, the presence of ankle-clonus, and an absence of the ocular symptoms, nystagmus, and the scanning speech. A rare family disease has been described by Purves Stewart in which ataxic paraplegia associated with optic atrophy appeared at the age of seven years or earlier. He termed it "hereditary amaurotic ataxic paraplegia."

Disseminated Sclerosis.—In this disease the tendon-jerks are usually increased, optic atrophy, indicated by a pallor of the temporal halves of the disks, is present; the speech is more likely to be sing-song instead of thick and indistinct, and epileptiform and apoplectiform attacks are liable to occur, and the disease usually comes on later in life (twenty to thirty years).

The **prognosis** is necessarily bad. The disease is progressive, though it does not kill directly. It may last thirty years or more.

Treatment.—Little or nothing can be accomplished. It is well to employ measures to improve the nutrition of the patient.

HEREDITARY CEREBELLAR ATAXIA

(*Marie and Nonne*)

In this type the most pronounced pathologic change in most cases is an atrophy of the cerebellum, in others defective development of the tracts in the cord leading to the cerebellum has been found. The etiology and symptoms are similar to those of Friedreich's disease, except that it usually develops somewhat later in life, the knee-jerks are present or increased, and optic nerve atrophy, diplopia, and Argyll Robertson pupil may be found.

ATAXIC PARAPLEGIA

(*Posterolateral Sclerosis*)

This name was given by Gowers to a condition in which spastic paraplegia and ataxia coexist, owing to simultaneous involvement of the lateral and posterior columns. A similar condition may follow an acute myelitis, representing the chronic type of that disease (p. 1096). Disseminated sclerosis may possibly present the same symptoms. The type Gowers' describes occurs chiefly in males of middle age. Traumatism and exposure seem to predispose to the disease, as does syphilis.

Symptoms.—These develop insidiously. The patient tires rapidly, and some impairment of the power of walking is observed. In turning quickly he stumbles, and there is difficulty in walking in the dark, or even in standing when the feet are close together. The reflexes are increased at an early date,

and spasticity supervenes and is progressive, though it never becomes as marked as in uncombined lateral sclerosis. The gait is somewhat similar to that met with in locomotor ataxia, but it lacks the forcible stamp present in *that disease*. When the arms are involved the same ataxia, with weakness, spasticity, and increased reflexes, is met with. Sensory symptoms are generally absent and fulgurant pains are never present. When pain occurs at all, it is of a dull character and often in the sacral region. Optic atrophy does not occur. Sexual power is lost. The sphincters are not usually involved, though retention of urine may occur. Ultimately, the case generally partakes more of the nature of a lateral sclerosis, but the features of a posterior sclerosis may rarely predominate. Mental symptoms often develop in the late stages. The so-called Erb's type of syphilis of the cord produces a very similar group of symptoms. In this, however, there is incontinence of urine and sometimes of feces.

The *diagnosis* is easy in typical cases. The ataxia, with myotatic irritability and spasticity in the absence of sensory and ocular symptoms, is characteristic.

The *treatment* consists in maintaining the general health by proper hygiene, food, etc. If due to syphilis, a vigorous antisyphilitic treatment is necessary (p. 1146).

COMBINED SYSTEM SCLEROSIS

(Subacute Combined Sclerosis of the Spinal Cord; Diffuse Degeneration of the Cord)

This affection, while described by many as a true combined sclerosis or system disease (p. 1034), is more correctly classified as a diffuse process, as has been done by Putnam and Taylor. It was first described by Lichtheim in 1887 in cases due to pernicious anemia. Putnam in 1891 described cases due to other causes, viz.: influenza, chronic diarrhea, lead-poisoning, and malaria. It occurs most frequently between thirty and sixty, and always follows some chronic wasting disease or toxic condition. It has been described in pellagra.¹

The posterior columns are usually first and most involved. The lateral columns, especially the crossed pyramidal tracts, are also soon affected. Other tracts may become affected later, as do also the cells in the anterior horns and, in some cases, the anterior nerve-roots. The blood-vessels in the affected areas are engorged, their walls thickened.

The initial symptom is usually a persistent paresthesia, usually of the feet; with this some weakness, rigidity, and possibly ataxia will be found. Later the arms become similarly affected. At this time the tendon-jerks will usually be found increased. There may also be pain in the back and limbs. Later the muscles become flaccid and the deep reflexes lost. Late in the course of the disease loss of sensation and muscular atrophy may also occur and elevation of temperature and delirium.

The *diagnosis* is based upon the presence of the above symptoms occurring in one suffering from any of the causes mentioned.

The *prognosis* is bad, death usually occurring in from six months to three years.

The *treatment* consists of general measures to combat the cause, if known, and improve the general health. If anemia exists, iron and arsenic should be given in full doses.

¹ *Amer. Jour. Med. Sci.*, January, 1911, p. 94.

SYRINGOMYELIA

Definition.—A neuroglial overgrowth of more or less vertical extent, and situated in the gray matter of the cord in the neighborhood of the central canal. Its symptomatology is not constant, but the following have come to be looked upon as typical of most cases, viz.: progressive muscular atrophy, trophic and vasomotor disturbances, and dissociation of sensation (*i. e.*, impairment or loss of temperature and pain sense, with retention of the tactile and muscular sense).

Etiology.—The symptoms usually develop during the second or third decades. The exciting cause is uncertain. Traumatism by producing hemorrhage into the gray matter possibly may cause some cases. Many sufferers from this disease have congenital anomalies of various sorts, as abnormal smallness, disproportionately large hands and feet, varieties of club-feet, etc. Syphilis plays no direct part, but may have some influence by its causation of diseased blood-vessels.

Pathology.—The usual seat of the process is in the cervicodorsal region, but it may be in other regions or extend throughout the length of the cord, even into the lower part of the pons (syringobulbia), and very rarely, as shown by Spiller, into the lateral ventricle (syringo-encephalomyelia). It consists of an overgrowth of neuroglial tissue (gliomatosis) in the region of the central canal of the cord. This breaks down and forms a cavity, which usually extends irregularly in a transverse direction backward into the posterior horns, or may extend into the anterior. The cavity is lined with a varying thickness of gliomatous tissue. Secondary degenerations occur in the white matter, either ascending or descending, according to the tracts cut off. In most cases the condition results from a congenital anomaly of the central embryonal tissue, resulting during the early years of adult life in a slow-growing hyperplasia, having some of the characteristics of a benign neoplasm and a marked tendency toward the formation of cavities.

Symptoms.—Owing to the fact that different levels of the cord are involved, and that the extent claimed by the process varies in different cases, it will readily be understood that no account, however concise, will fit every case. The disease is of *slow onset*. The commonest situation of the cavity is the lower cervical region; when this is the case the earliest symptoms appear in the hands, there is a numbness, loss of the pain and temperature senses, usually in an area bounded by a horizontal line surrounding the limb (glove anesthesia), and preservation of the touch sense. This constitutes the *dissociation of sensation*, perhaps the most characteristic symptom of the disease. The first symptom usually noticed is weakness and atrophy of the muscles of the hands, which show changes in the electric reactions and fibrillary tremors, as in progressive spinal muscular atrophy. The atrophy may begin in other groups, according to the location of the lesion. Vasomotor and usually trophic changes occur in the ends of the fingers, especially multiple painless whitlows. Neuralgic pains and often exaggeration of the tendon reflexes are present in the arms. At the same time the syndrome of the transverse lesion of the spinal cord develops there is spastic paresis of the legs and disturbance of the functions of the bladder and rectum. As the disease progresses the symptoms become more general. The pain and temperature sensations are lost over large areas, the tactile and muscular sensations are preserved; there may, however, be areas in which all forms of sensation are lost. The trophic lesions are various; Charcot's joint or a dry arthritis may occur, there may be extensive bed-sores, or slight injuries may lead to chronic sores. Vasomotor disturbances are common, especially in the secretion of sweat. As a result of unequal in-

involvement of the muscles of the back lateral curvature of the spine occurs. Not infrequently, as a result of the involvement of the posterior column, incoordination, with loss of knee-jerks, similar to that observed in *tabes dorsalis*, may develop.

As the morbid process extends upward the centers in the medulla become involved, giving rise to bulbar symptoms, such as paralyses of the cranial nerves and disturbances of the urinary secretion. These are usually terminal signs. The symptoms, of course, vary with the position of the lesion in the cord, and in rare cases they may commence in the legs or indicate primary involvement of the medulla.

The disease originally described by Morvan of Brittany in 1883 should be included here. He had observed many cases prior to that time, but his attention was specially called to the matter by a case of whitlow which he incised, but to his surprise no pain whatever was experienced. He described *the disease as affecting the upper extremities*, with neuralgia, progressive paresis and wasting, dissociated anesthesia, and later painless whitlows and necrosis of the phalanges. Joffroy and Achard have made three autopsies upon cases dying of this disease, and in each syringomyelia was found. In Gombault's case neuritis was present. The current view is that *Morvan's disease* is a variety of syringomyelia.

Diagnosis.—The loss of pain and thermic sense, with preservation of the muscular and tactile senses, in association with the muscular wasting, which is most marked in the upper extremities; and with the spasticity of the lower extremities, and the trophic changes, especially in the fingers, constitute a group of symptoms that has come to be regarded as typical.

Differential Diagnosis.—*Hypertrophic cervical pachymeningitis* may be mistaken for this disease, and *vice versa*. In this case, however, the pain is usually greater, the tactile sense is apt to be lost, and possibly the other senses also; but there is not the dissociation met with in syringomyelia. *Amyotrophic lateral sclerosis* presents neither sensory nor trophic symptoms other than the muscular wasting. *Disseminated sclerosis* is characterized by intention tremor, disturbance of speech, nystagmus, while sensory symptoms are rare. Hemorrhage into the gray matter of the cord may cause a similar symptom-complex; in this, however, the onset is acute, and usually follows traumatism. The neural form of *leprosy* may present a clinical picture that is difficult to differentiate. There are dissociation of sensation, trophic changes in the fingers, and muscular degeneration. In leprosy, however, nodular thickening of the nerves may be felt. The facial nerve is often affected first and the bacillus of leprosy can be found in the nasal mucus. Spasticity of the lower limbs does not occur.

The **prognosis** is always unfavorable, though the disease runs a very chronic course, lasting even fifteen or twenty years.

Treatment.—Nothing can be done except by attention to hygienic and dietetic details.

IV. DISEASES OF THE BRAIN

DISTURBANCES OF CIRCULATION OF THE BRAIN AND MENINGES

Meningeal Hemorrhage.—Hemorrhage may be (1) extradural—(a) traumatic and (b) due to rupture of a vessel by erosion, the result of caries; or (2) intradural—into the so-called arachnoid sac—(a) traumatic; (b) due to

injuries at birth (p. 1123), (c) due to pachymeningitis interna; (d) met with in general paralysis of the insane; (e) occurring in the course of anemia, scurvy, or some other profoundly altered blood condition; (f) in cardiac, renal, or pulmonary disease; (g) the result of strain—*e. g.*, whooping-cough.

The **symptoms** will depend upon the circumstances, whether the amount of blood is small or large, whether the onset is *gradual* or *abrupt*; they may be further obscured by the primary disease or by *shock*, if the cause is some trauma. In the slight forms absolutely nothing characteristic exists. In others there are *headache, vertigo, vomiting*, and possibly *mental confusion, convulsions*, or *coma*; in fact, the ordinary symptoms of apoplexy. The blood-pressure is increased. Cases due to traumatism are of most importance, both from a diagnostic and therapeutic point of view. If extradural, the hemorrhage is usually from a branch of the middle meningeal. When such is the case the symptoms are characteristic. They consist of a varying period, in extreme cases a day or more, in which, with the exception of a brief period of evidences of concussion, there are no symptoms, the patient possibly going about his business. Then he gradually becomes more and more stupid, muscular twitching, and some degree of paralysis upon the side opposite the seat of hemorrhage, and if the posterior branch is the one affected, sensory symptoms appear. A choked disk and Babinski reflex may also be found on this side and a dilated pupil upon the side of the hemorrhage (Hutchinson's pupil). When the hemorrhage is subdural the symptoms usually appear more quickly and the paralysis is more profound. In these cases blood will be found in the cerebrospinal fluid.

The **treatment** is that of cerebral hemorrhage except in those due to traumatism, when opening the skull over the seat of hemorrhage should at once be done. Cushing has recently done this in infantile cases with success.

HYPEREMIA

Definition.—An abnormal increase in the amount of blood in the cerebral capillaries. The condition is not in any way associated with the primary phenomena of inflammation.

What has already been mentioned in the case of hyperemia of the cord is equally true in this case—*viz.*, that while congestion undoubtedly may take place, there is nothing symptomatically pathognomonic in the fact, and hence we do not recognize it as a definite clinical entity. The transient apoplectic form seizures, which may occur during the course of paresis, brain tumors, and multiple sclerosis, have been ascribed to a sudden congestion; in other words, a localized active hyperemia. They should be treated by slight elevation of and cold applications to the head, mild purgation, and bromids internally.

Passive congestion is met with in cases of obstruction of the cerebral sinuses and veins, and is due to pressure on the superior cava or the innominate or jugular veins by tumors or aneurysms; also in suffocation and strangling, in cases of excessive strain, and in tricuspid insufficiency.

In passive congestion the veins and sinuses are engorged and more or less edema may be present. It may be suspected if in cases of mitral and tricuspid valvular disease of the heart chronic headache and hebetude occur.

The **treatment** in such cases will consist in endeavoring to restore the circulation to as near the normal condition as possible (p. 639).

ANEMIA

Definition.—A condition in which an insufficient amount of blood circulates in the cerebral capillaries.

It is due to exhausting discharges (diarrhea), an abnormally slow pulse or weak heart, to hemorrhage, obstructive endarteritis of the vessels supplying the brain, to syncopal attacks and dilatation of the intestinal vessels, owing to the too rapid withdrawal of ascitic fluid.

Disease of the blood itself may also cause the symptoms attributed to anemia of the brain.

Symptoms.—The most exaggerated type is met with after a profuse hemorrhage. There are *pallor, weakness, vertigo, headache, flashes of light, subjective noises, rapid respiration, cool skin*, possibly profuse sweating, and in extreme cases *coma, convulsions, and death*. We are more familiar with the ordinary fainting attack. When cerebral anemia is brought about more slowly, "irritable weakness" results. The patient is either *somnolent, dull and apathetic*, or he may be a victim of *insomnia*. *Headache, vertigo, tinnitus aurium, muscæ volitantes*, and lowered muscular power are present. The patient becomes irritable on the slightest provocation. Marshall Hall has described a group of symptoms as "hydrocephaloid," from their resemblance to hydrocephalus; they occur especially in young children after diarrhea. There are *pallor, hebetude, contracted pupils, and depressed fontanelles*. The somnolence may deepen into a coma that often becomes more profound, until death results.

The transient attacks of paralysis and loss of consciousness which occur in those suffering from arterial sclerosis are due probably to a localized anemia caused by spasm of the vessels supplying the particular part of the brain affected.

The **treatment** varies with the cause. The recumbent posture is always indicated, and in some cases it is necessary to depress the head, administer stimulants, and even transfuse or inject a normal saline solution. Ordinarily it consists of improving the tone of the circulation and quality of the blood. In the transient apoplexies caused by arteriosclerosis, nitroglycerin in full doses is of service. A light and easily assimilable diet should be given during convalescence.

EDEMA OF THE BRAIN

Definition.—An infiltration of serum into the subarachnoid space and a greater or less increase of ventricular fluid, with or without infiltration into the brain substance.

Pathology.—The fluid is chiefly in the meshes and beneath the membrane. The ventricular fluid is increased in amount; the brain substance is pale, and in some cases infiltrated and softened. Microscopically, lacunæ may be seen in the cerebral tissue, the perivascular spaces are dilated, and some slight degree of nerve-cell degeneration is often present.

Etiology.—Edema is met with in Bright's disease, in senile cerebral atrophy, and as a result of passive hyperemia.

Symptoms.—In general, the symptoms are those of *anemia*, though nothing definite is known of them. Since the condition is always secondary, it may be that symptoms directly referable to the edema are masked by the primary condition. Cases of apoplexy are seen occasionally in which the only post-mortem finding is an effusion of fluid into the pia and ventricles. This has been termed "serous apoplexy." (See also Serous Meningitis, p. 1081.)

The **treatment** is that of the primary condition. Lumbar puncture may be employed.

VASCULAR DEGENERATION

Arterial.—The cerebral arteries undergo a more or less decided degenerative change in the majority of people past middle life (Bichat said seven-tenths).

CEREBRAL HEMORRHAGE

Definition.—Hemorrhage into the brain-substance: bleeding into the meninges is generally embraced in the definition (p. 1111).

Pathology and Etiology.—At the time of birth and during the first ten years of childhood there is some tendency to cerebral hemorrhage (see p. 1123). From this period to the age of forty the liability is small; after this, it progressively increases. The predisposing causes are alcoholism, syphilis, and gout. Hereditary influence may also be a factor, as may also the infectious fevers. Rarely it complicates scurvy and purpura hemorrhagica. The exciting causes are lifting heavy weights, straining at stool, coitus, and mental excitement; but hemorrhages occur in which no exciting cause can be determined. These causes are usually only operative in those predisposed. Transient apoplectic attacks, due to sudden congestion, may occur in multiple sclerosis, brain tumor, and paresis. In intracerebral hemorrhage the blood will be found to have infiltrated the brain substance, and, if extensive, it may have penetrated into the ventricle. In such cases the white matter is torn asunder, leaving a ragged space that is more or less filled with recent clot and fragmentary gray matter; if the ventricles have been entered, blood may escape from the lowest into the subarachnoid space. In less severe cases the territory involved is less extensive, and the blood may occupy a single space or several small spaces, forming mere separations of the nerve-fibers. Other changes take place according to the duration of the case. The blood changes color and gradually grows lighter, while reactive inflammation about the lesion results in the formation of a wall. The cyst—for such it has become through fatty degeneration of its contents—may remain as such or, when the lesion is a small one, connective tissue may form within and a scar result. The larger arteries are generally atheromatous, and an aneurysm is occasionally met with. The actual cause of the hemorrhage in most cases is the rupture of a miliary aneurysm, which is a tiny dilatation upon a small vessel. Many of these can usually be seen on the degenerated vessels of a brain in which such rupture has occurred. The vessels otherwise present the changes of arteriosclerosis. A vessel may, however, rupture when miliary aneurysms are not present. Hyaline degeneration may in some cases be the condition present. Rupture may also occur in an area of softening due to extension to the vessel wall of some neighboring form of inflammation. Such cases appear often to be due to injury to the head, the hemorrhage occurring some little time after the reception of the injury (delayed apoplexy). It is very seldom that the actual source of the hemorrhage can be discovered.

Secondary degeneration follows a lesion occurring in the motor region (the cortex or internal capsule), so that sclerotic changes can be traced from the cortex through the corona radiata, internal capsule, crura, pons, and medulla, to the termination of the fibers in the cord.

Andral states that varicose veins occur in the pia, and that they occasionally rupture. Capillary hemorrhage may follow the plugging of a large vein, and of the larger vessels any one or more may be involved, but it has been observed that hemorrhage tends to take place at particular places. In more than one-half of all cases the lenticulostriate artery (Charcot's artery of cerebral hemorrhage) gives way, and damages the lenticular nucleus and internal capsule. Other regions in the order in which hemorrhage occurs are as follows: centrum ovale, cortex, pons, peduncle, cerebellum, optic thalamus, and the posterior and anterior parts of the hemispheres. Hemorrhage into the cerebrum occurs twenty times more often than hemorrhage into the cerebellum; it may take place into the brain substance, into the ventricles, or into the meninges,

degree of recovery is dependent upon the resumption of function of slightly damaged tissue or upon the compensatory activity of the other side of the brain. In certain cases the structural damage has been too great, and permanent paralysis remains, with rigidity, slight wasting, secondary contractures, and increased deep reflexes.

Ingravescent Apoplexy.—In certain cases the onset is slow, consciousness being lost gradually. Coma deepens, and the case, as a rule, terminates fatally.

Ventricular Hemorrhage.—This may be primary or secondary. The symptoms are very severe and death soon occurs. Blood may be found in the cerebrospinal fluid obtained by lumbar puncture.

Hemiplegia.—When this is complete, one side of the face and the arm and leg of one side, generally the same, are all involved (see Pontine Hemorrhage). The facial palsy is not complete, the frontalis and orbicularis oculi escaping. The tongue when protruded deviates toward the paralyzed side. As a rule, the arm is affected to a greater extent than the leg. The trunk muscles, those of the upper part of the face (p. 1060), and muscles of swallowing and speech nearly always escape (see p. 1019). If a second lesion later involves the other side, bulbar symptoms, as difficulty in swallowing, indistinctness or loss of speech, and complete paralysis of the tongue, develop with more or less severity (pseudobulbar palsy). The history and absence of atrophy of the tongue distinguishes this from true bulbar palsy (p. 1087). The paralysis is usually spastic, and, therefore, the tendon reflexes on the paralyzed side are increased, and the Babinski phenomenon is present. The abdominal, cremasteric, and other skin reflexes are lost on the affected side. The reflexes upon the unaffected side are also exaggerated, but the pathologic forms are rarely present. If the *lenticular nucleus* alone is involved spasticity occurs without paralysis.

Sensation is, of course, absent during the period of unconsciousness. Subsequent sensory disturbances are not constant for all cases. In some cases permanent anesthesia for all forms of sensation upon the affected side persists, with loss of the skin reflexes. This indicates a lesion in the posterior part of posterior limb of the capsule, and lateral homonymous hemianopsia is usually associated. Occasionally only dissociation of sensation is present, tactile sensation being preserved, while muscular and thermal sensation are lost or diminished. The stereognostic sense is often seriously disturbed in these cases.

The special senses may be temporarily perverted or their functions in abeyance, but rarely do permanent disturbances occur.

Pontine Hemorrhage.—This is indicated by marked contraction of the pupils, temperature, and paralysis of cranial nerves upon the side of the hemorrhage and of the arm and leg upon the other (crossed paralysis). Bulbar symptoms may remain permanently.

Crossed Hemiplegia.—When a lesion occurs in the lower part of the pons the fibers of the facial nerve that are involved have already decussated; hence facial palsy occurs on the same side as the lesion. The fibers coming from the cortex are implicated before their decussation, so that paralysis of the limbs occurs on the side opposite to the lesion. Lesion of the crus may lead to oculomotor palsy of the same side, and palsy of the face, arm, and leg of the opposite side.

Reference to pp. 1017–1022 will indicate the symptoms which may occur when a hemorrhage occurs in other parts of the brain.

Serous Apoplexy.—The cases present clinical evidences of apoplexy, but the only *postmortem* finding is an excess of serum, and this is in no way responsible for the apoplexy. These cases probably belong in the same

particularly if the deep reflexes are exaggerated on the flaccid side, and a Babinski reflex and conjugate deviation of the head and eyes present, the probability is that it is an apoplectic attack. It is of great importance to tell whether the condition is due to hemorrhage, embolism, or thrombosis, although at times this may be impossible. The tabulated points of distinction given below may afford aid:

EMBOLISM

Early adult life.

Previous development of cardiac disease following acute rheumatism, sepsis, chronic valvular disease, aneurysm, pregnancy.

During the attack there is an absence of congestion of the face; the pulse is normal; in cardiac affections it is accelerated and irregular.

Temperature normal or but slightly disturbed.

The attack, as a rule, is short; if there is a protracted embolic infarction, the duration is long; usually the circulation adjusts itself promptly.

Hemiplegia is right-sided usually. Paralysis may occur first, followed by convulsions and coma.

Ophthalmoscopic Examination

At times the ophthalmoscope reveals either a recent or an old embolus in the arteria centralis retinæ.

HEMORRHAGE

Late adult life; in early life rare.

Cardiac hypertrophy, arteriosclerosis, increased arterial tension. In children, previous infectious disease.

History that the patient up to the time of attack was well; also the finding of casts in urine and other symptoms of chronic nephritis.

During the attack there are noted flushes (reddish) of the face, pulsating carotids, and slow pulse.

Temperature during the attack is subnormal, followed by a rise, especially on paralyzed side.

The duration is, as a rule, longer. Coma of long duration (about two days) gives a very unfavorable prognosis.

Remote effects quite frequent; alteration in the urine—albuminuria, polyuria.

The retinal arteries may show various stages of arteriosclerosis; as a result there may be a hemorrhagic retinitis or there may be a thrombus of the central vein of the retinæ. A mild degree of choked disk may be present.

THROMBOSIS

Prodromes, as transient attacks of weakness, numbness, vertigo and headache, frequent.

Consciousness frequently preserved.

Age of patient greater (after fifty), except in syphilitic cases, when it may occur in early adult life.

Paralysis may develop slowly, sometimes several taking hours to become complete.

Temperature changes not so marked (initial fall followed by rise).

Attacks occur while patient is at rest (during sleep).

Pulse weak, breathing quiet. Face not flushed. Vessels atheromatous.

Pupillary disturbances not marked.

HEMORRHAGE

Prodromes not very frequent.

Usually lost.

More apt to occur between forty and fifty.

Develops at once.

Temperature changes marked.

Attack occurs during physical exertion.

Pulse slow and full, blood-pressure increased, breathing stertorous, face flushed.

Pupils unequal or contracted.

It is not an uncommon occurrence to have patients brought to a hospital dazed and smelling of liquor. These should always be carefully watched, for mistakes readily occur, and many such cases have been condemned to a prison-cell when they were really suffering from cerebral hemorrhage.

Treatment.—If a diagnosis of hemorrhage cannot be positively made, care must be taken not to do harm: should be expected.

often fatty change. The color of the part varies with the amount of blood. In recent cases it is red. As the hemoglobin is absorbed a yellow color appears, and soon predominates. Red and yellow softening are found chiefly in the cortex. The so-called white softening is met with particularly in the white matter. A variety of red softening in which numerous small hemorrhages exist has been termed "capillary apoplexy," while *plaques jaunes* is the term given by the French to a form of yellow softening often seen in the cortex of old people. The ultimate changes depend in a great measure upon the extent of the lesion. If this is small, the granular débris is absorbed, and the proliferation of connective tissue results in the formation of a scar. On the other hand, if large the solid elements are removed, and the cavity that remains contains more or less fluid (a cyst). In many instances fibers, trabeculæ, and even vessels that have escaped destruction pass through the cyst.

Thrombosis.—Definition.—Obstruction of a vessel due to clotting *in situ*. This may occur (a) in the arteries or (b) in the veins and sinuses.

IN THE ARTERIES.—Etiology.—Thrombosis results from disease of the vessel wall, atheroma, endarteritis, or syphilitic arteritis, extension from surrounding diseased areas, traumatism, in aneurysms, in depraved blood states, and at the seat of lodgment of an embolus. Thrombosis of a cerebral vessel may rarely follow ligation of the carotid. In general we may say thrombosis results from (1) changes in the vessel wall, (2) retardation of the blood-current, and (3) hypercoagulability of the blood. It occurs most frequently in the middle cerebral, basilar, internal carotid, and vertebral arteries.

Pathology.—The changes in the brain tissue are precisely those described under Embolism. Within the vessel a clot is found adherent to the vessel wall, and extending from the nearest large branch on the proximal side to the contracted branches on the distal side. If of recent and rapid formation, it is always of a red color. The slower the formation, the paler the color. Such clots are often laminated. The ultimate changes are contraction and atrophy, or, more rarely, calcification, or even softening and removal, the vessel again becoming patulous.

IN THE VEINS AND SINUSES.—Etiology.—Thrombosis may be (1) primary, due to general causes, or (2) the result of local changes.

Primary thrombosis is less common than the secondary variety. It is met with in marasmic children (one of the causes of infantile hemiplegia—Gowers), in which the clot is called marantic thrombosis, cachexia, phthisis, carcinoma, and in blood dyscrasiæ (anemia, chlorosis).

Secondary thrombosis usually results from an extension of neighboring forms of inflammation, caries of the bone, middle-ear disease, or meningitis. It may also be due to fracture of the skull or compression of a sinus by a tumor.

Pathology.—In primary thrombosis the most common seat is the superior longitudinal sinus. From this it spreads into the veins of both sides, and frequently also into the lateral sinuses of one or both sides. In secondary thrombosis the sinus nearest the local disease suffers. The veins emptying into the sinus involved become distended, often rupture, and in consequence the brain tissue and pia become infiltrated. When the veins of Galen are blocked serum escapes into the ventricles. Red, yellow, and white softening is met with as a final result of the extravasation. Secondary thrombi are usually septic, and give rise to abscess formation.

Symptoms.—Following Embolism or Thrombosis of Arteries.—The symptoms necessarily depend upon the position and extent of the lesion. Extensive lesions may occur in those portions of the brain that never yield any localizing symptoms—the frontal region, for ~~from~~ the etiologic differences the clinical pictures of ~~as~~ follows: In the former the onset is sudden many cases

be made to prevent the spread of the process. Rest in bed with the head low should be insisted on. When shock is present, it must be met by gentle stimulation, ammonium carbonate, and even by alcohol and digitalis in some cases; hot-water bottles may be applied to the body. Citric acid, in the form of lemon-juice, may be given to prevent further coagulation. Venesection is contraindicated. The bowels should be made to move gently and purgation should be avoided. Nitroglycerin and small doses of the iodids are useful in thrombosis. If the blood-pressure is low, caffein may be added. Later, as stated, symptoms of irritation often appear. In such cases the bromids should be given, and also a diaphoretic mixture, or ice should be placed to the head. In any case in which syphilis, rheumatism, gout, chorea, or other malady capable of causing or adding to the trouble exists, the original disease should be treated promptly and thoroughly. In the meantime efforts should be made to improve the patient's general tone by the strict observance of hygienic and dietetic rules.

Of Thrombosis of Veins and Sinuses.—Treatment in these cases depends largely on the cause. In the primary form it is that of the systemic disease. Good, wholesome, and easily assimilable food should be given, together with a tonic treatment. In secondary thrombosis careful search should be made for pent-up inflammatory products, which should be liberated at the earliest possible moment. The brilliant results of operative interference in some apparently hopeless cases should suggest its employment whenever there is good reason for suspecting septic sinus thrombosis. The emunctories must act freely. Counterirritation applied to the neck is of questionable value, but internally quinin, iron, and strychnin, and, if stimulation is necessary, ammonia and alcohol, will all be useful.

CEREBRAL PALSIES OF CHILDREN

The paralysis may involve all four extremities (diplegia), or be monoplegic, paraplegic, or hemiplegic in its distribution.

Etiology.—They may be congenital or develop during the first few years of life, usually within the first two. The former, in the great majority of instances, are due to meningeal hemorrhage, usually occurring during birth. In such cases there is often a history of difficult or forceps delivery; it may occur, however, during easy labors. When due to this cause, the symptoms are frequently diplegic, but may be either hemiplegic or paraplegic. Some are possibly due to a fetal meningo-encephalitis due to infectious disease in the mother, or traumatism, especially abdominal, while pregnant; another cause may be lack of development of the motor tracts, and in such cases a history of premature labor may be obtained. Either neurotic taints, alcoholism, or syphilis in the parents may have some influence in the causation. The congenital cases have been known as *Little's disease* and *birth palsy*. Jaundice in the newborn is also a cause.

The hemiplegic form is most frequent in the latter group. These cases usually follow the infectious diseases, and are due in some instances to either hemorrhage, thrombosis, or embolism in a branch of the middle cerebral artery; others may be due to a cortical polio-encephalitis (Strümpell) (p. 1127).

Pathology.—If the patient live for a number of years, the following lesions may be found: atrophy and sclerosis, either of a group of convolutions, an entire lobe, or the hemisphere is most frequent. The affected parts are firm and hard, and the convolutions smaller than the normal. The sclerosis may be diffuse, and there may be nodular projections (*hyertrophic sclerosis*).

The history of the development of this condition and absence of cerebral symptoms easily distinguish the two. Athetosis may be mistaken for chorea; the history and presence of evidence of disease of the pyramidal tracts and rhythmic character of the movements are sufficient to make the distinction. Children with visible telangiectasis who develop cerebral symptoms may also have the brain similarly affected. Forms of diffuse sclerosis of the brain have also been described in young children some of which are due to hereditary syphilis. Another type described by Krabbe¹ is a family disease, the symptoms of which appear at about the age of five months and are characterized by intense spasticity, tonic spasms aggravated by peripheral irritation, and sometimes nystagmus and atrophy of the optic nerve. Death occurs in five or six months. Another type resembles multiple sclerosis (p. 1140).

Prognosis and Treatment.—This, as regards duration of life, is good; as regards disability and cure, is bad. The symptoms may be relieved. If the diagnosis of hemorrhage during labor is suspected, lumbar puncture should be done, if confirmed and improvement is not caused by the puncture the skull may be opened and the clots removed, as has been successfully done by Cushing. If spasticity is much greater than paralysis, relief may be obtained by cutting some of the posterior nerve-roots, as recommended for lateral sclerosis (p. 1104). Usually the treatment consists in passive movements and electricity applied to the extensor muscles to overcome the spasticity. Tenotomies and tendon transplantations may also be necessary. Sharpe and Farrell² have performed cerebral decompression in a number of cases with encouraging results. The cases so operated upon were those in which there was a history of difficult labor and in whom ophthalmoscopic examination showed evidences of intracranial pressure. The failure of mental power, if it exists, must be treated, if not too extreme, by proper educational measures, and the epileptiform convulsions, if they occur, by the measures recommended for that disease (p. 1160.)

PROGRESSIVE LENTICULAR DEGENERATION

This is a rare condition described by Wilson.³ It may attack several members of a family, but is not hereditary. It always occurs in young people, and may be either acute or chronic. The symptoms consist of bilateral tremor of the limbs which is increased by volitional movement (sometimes the head also is affected); spasticity of the limbs and face; dysphagia and dysarthria and finally anarthria; sometimes causeless laughter and emotionalism; difficulty in maintaining the equilibrium owing to the spasticity; sometimes transitory mental symptoms. There is no real motor weakness and the reflexes are normal. Cirrhosis of the liver is always associated, but no evidence of disease of the liver is present during life. Death occurs in from six months to five years, and in all the cases examined a bilateral symmetric softening of the lenticular nucleus was found. Wilson believes it to be due to a toxin which probably has some relation to the cirrhosis of the liver. In this connection the softening of the lenticular nuclei, due to carbon monoxid poisoning, is of interest. These cases, the symptoms of which may appear several days after the patient has apparently recovered, have spasticity of the limbs and stupor, the reflexes, however, may be increased and the Babinski phenomenon present.⁴ (See also Pseudosclerosis, p. 1143).

¹ *Brain*, 1916, p. 74.

² *Jour. Amer. Med.*

³ *Brain*, 1912, p. 20

⁴ McConnell and

Chronic abscess develops, as a rule, insidiously; of the general symptoms, fever of a hectic type is most important, and there is usually a moderate leukocytosis. The pulse may be very slow. Headache, often severe and localized, is common, and there may be frequent vomiting. There is often vertigo, occasionally convulsions, and sometimes choked disks. Cachexia may also occur. The focal symptoms are of the utmost importance. The commonest is hemiparesis of the opposite side, but hemianopsia, hemihypesthesia, or unilateral loss of the muscle sense, and astereognosis may also be present. A peculiar feature of chronic abscess is the slowly progressive character of the symptoms, indicating extension forward or backward in the line of least resistance, and not increasing pressure in one place, as in the case of tumor. Occasionally the abscess ruptures spontaneously into one of the cavities of the head (nasal, aural), and temporary relief may be experienced. An abscess may be "latent" in almost any region, these latent abscesses being typified in certain cases of congenital heart disease. I do not think they were suspected during life in any of the cases reported thus far, and therefore optic neuritis has not been looked for. When the abscess is due to ear disease, phlebitis of the lateral and superior petrosal sinuses frequently coexists; in such cases there will be edema about the ear and neck and hardness of the jugular veins.

Diagnosis.—In the acute cases following injury little difficulty presents as a rule, though even in this group a latent period may exist. With such a history, however, the onset of headache, fever, delirium, and convulsive movements is decidedly suspicious, and, should optic neuritis also exist, practically no doubt can remain. When aural or nasal disease exists the head symptoms should be carefully studied, since they are prone to develop in ear disease soon after a cessation in the discharge. A slow pulse associated with fever is very characteristic of abscess.

Differential Diagnosis.—Brain tumor usually runs a more chronic course, and is seldom accompanied by fever, at least not until its final stage. The causes of abscess are absent except in the case of tubercular tumors, when abscess may be associated. It may be impossible to differentiate cerebral abscess from meningitis, and the two conditions often coexist, as already stated.

The prognosis is always grave.

Treatment.—When an abscess is diagnosed immediate operation is indicated. Suspected cases may be treated symptomatically unless focal symptoms develop. It must be remembered, however, that in a great many cases no localizing symptoms appear, and, since we know that most abscesses occur either in the temporo-sphenoidal lobe or in the cerebellum, when we have reason to suspect the presence of one, these regions should be explored.

ACUTE HEMORRHAGIC ENCEPHALITIS

Definition and Varieties.—This is a condition characterized by foci of inflammation scattered throughout the gray matter of the brain that are not accompanied by suppuration. The cortex alone may be affected (encephalitis of Strümpell), and a certain number of cases of cerebral palsy in children (p. 1123) are due to the process being localized in the motor region. Adults also may be attacked. The gray matter about the aqueduct of Sylvius, with involvement of the nuclei of motor nerves of the eye, is a frequent seat (polio-encephalitis superior of Wernicke). The nuclei of other motor cranial nerves may be affected (acute bulbar palsy or polio-encephalitis inferior). The cerebellum also may be involved. These forms may occur either separately or combined.

Etiology.—These are chiefly chronic alcoholism and the acute infectious diseases, especially influenza and the virus of acute anterior poliomyelitis

are most pronounced in the regions mentioned in the definition. Microscopically are seen hemorrhages, engorgement of blood-vessels, round-cell infiltration, gliosis, chromatolysis, neuronophagia, and other evidences of cellular degeneration. Similar conditions are found in acute anterior poliomyelitis and to a certain extent in syphilis. The intensity of the hemorrhages is characteristic.¹ The lethargy has been explained as follows: All sensory stimuli pass by way of the optic thalamus to the cortex, and as it is so frequently the seat of the lesions of the disease the stimuli are interrupted there on the way to the cortex.²

Symptoms.—The onset may be sudden, but usually several days are required for the symptoms to develop. These vary somewhat. At first there may be some headache and fever with the development of apathy and apparent drowsiness; the patient can usually be aroused, however. The facial expression is often mask-like. Paralysis of various cranial nerves, especially the third, sixth, and seventh, usually develops. They may be slight or absent. The ophthalmoplegia is usually bilateral, but frequently not complete. Diplopia may be complained of as an early symptom. In some cases the apathy does not develop for several days and be preceded by either euphoria or delirium, or it may never be marked. Other symptoms which may be present are extreme restlessness, mania, marked hallucinations, especially of sight, tremor of the paralysis agitans type, muscular twitchings, especially of the abdominal muscles, catatonia, giddiness, vomiting, slight meningeal symptoms, as rigidity of the neck and Kernig's sign. Rarely symptoms pointing to involvement of the pyramidal tracts may be present. Bassoe³ has described cases in which there was pain in the limbs. The disease may develop at any age. Tilney⁴ mentions 3 cases occurring in infants between four and six weeks old.

Examination of the cerebrospinal fluid is often negative. Pleocytosis and increased pressure may, however, occur. A mild leukocytosis is present.

Prognosis.—The mortality in different series of cases reported has varied from 3 to nearly 50 per cent. It is, therefore, a serious disease. Death may occur in a few days or not for a number of weeks. More or less residual paralysis, muscular rigidity, or tremor may be left in those who recover, and a neurasthenic state may continue for some time.

Diagnosis.—The disease must be distinguished from hemorrhagic encephalitis of the ordinary type, acute anterior poliomyelitis, tubercular meningitis, cerebrospinal syphilis, brain tumor, and botulism. Sporadic encephalitis (p. 1127) follows an acute infectious disease or either metallic or alcoholic poisoning. Stupor is not a prominent symptom. The history of development is not that of anterior poliomyelitis (*vide*). Tubercular meningitis occurs usually in childhood, headache at first is intense and cranial nerve palsies develop later in the disease. The acute onset and fever eliminate both tumor and syphilis. Either ptomain poisoning or botulism follows the ingestion of certain articles of food, and others who have partaken of it will probably have symptoms.

Treatment.—This is symptomatic. Plenty of easily digested food should be given and elimination encouraged. Lumbar puncture has apparently been of value. Hexamethylenamin or salol may be given. In view of the observations of Loewe and Strauss⁵ cleansing and disinfecting of the nasopharynx as in acute poliomyelitis is important.

¹ *Loc. cit.*, also Tilney and Riley, *Neurolog. Bulletin*, March, 1919, p. 106; also Kinier-Wilson, *The Lancet*, July 6, 1918, p. 7.

² Flexner, *Jour. Amer. Med. Assoc.*, March 27, 1920, lxxiv, 866.

³ *Jour. Amer. Med. Assoc.*, April 10, 1920, lxxiv, 1009.

⁴ *Loc. cit.*

⁵ *Loc. cit.*

INTRACRANIAL GROWTHS

(Brain Tumors)

Owing to their close relationship, new growths, both of the brain and membranes, are here considered.

Pathology.—Rindfleisch has classified intracranial tumors according to the tissue from which they spring, thus:

1. Having their origin in the *membranes*, either extracerebral or intraventricular; these include tubercle, gumma, carcinoma, sarcoma, myxoma, lipoma, cholesteatoma, and psammona; small fibroids have also been described. Enchondroma and osteoma may arise from the falx or from the bones of the skull.

2. From *blood-vessels*: to this group belong aneurysms, tubercles, and gummata.

3. Originating in the *neuroglial tissue*: glioma.

4. Originating in the *connective tissue*: sarcoma.

I will here consider these new growths in the order of frequency with which they are met:

1. **Tubercle** is most common in children and young adults, and is generally multiple (see Tuberculosis, p. 278).

2. **Sarcoma** is usually of the round- or spindle-celled variety; there may also be melanotic lympho- or fibrosarcomata. Sarcomata are apt to diffuse themselves through the brain substance quite rapidly.

3. **Glioma**.—Infiltrating tumors, generally single, and showing no definite line of demarcation from the surrounding brain structure. They may be soft, even telangiectatic, or quite firm. They often run a very chronic course.

4. **Gummata** are generally small and often multiple. They spring from the membranes or the adventitia of blood-vessels, or from connective-tissue septa. Frequently they are attached to the periosteum of the skull.

5. **Carcinomata** are secondary growths, and are generally small and round, but in some cases they perforate the bones of the skull, producing a fungus hematomides.

6. **Fibromata** are not common. They either grow in the membranes or aid in the formation of a mixed tumor, as fibrosarcoma. Other tumors met with less frequently are as follows: 7. **Osteoma**. 8. **Enchondroma**. 9. **Myxoma**. 10. **Lipoma**. 11. **Angioma**. 12. **Cholesteatoma**.

13. **Hydatids** are rare, especially in America. They may develop in any part of the brain or its membranes, and are said to occur most frequently in children. 14. **Cysticerci** may also occur in the brain or its membranes.

15. **Brain-cysts** are probably most often due to absorption of areas of softening from any cause, but they also occur between the dura and skull, as has been described. The lack of cerebral substance, due either to imperfect development or to atrophy following vascular obstruction or injury at birth, has been termed "porencephalia" by Heschl.

Etiology.—Age and sex are the chief factors; tuberculosis is far more common in children than in adults, while gummata when found appear almost invariably in adults, as do malignant growths. As a whole, new growths are more common between the twentieth and fortieth years, and males are more often affected than females. Traumatism seems to be an exciting cause in some instances.

Symptoms.—These are: (1) General and (2) focal.

General Symptoms.—*Headache* varies in degree and character; it is not of any value as a localizing symptom, nor is tenderness on pressure. Tenderness upon percussion, however, is often detected in the neighborhood of the tumor.

Vertigo in a mild form is quite a common symptom. In cerebellar cases it is often very marked.

Vomiting occurs in most cases, and generally bears no relation to the time

of taking food; this constitutes an important point in the diagnosis. The vomiting is apt to be exaggerated in cerebellar tumor.

Papilledema or choked disk (p. 1051) is present, according to Gowers, in four-fifths of all cases; in 82 per cent. according to Oppenheim, and in two-thirds according to Knapp. It occurs most frequently and early in tumors beneath the tentorium. It may develop rapidly and lead to complete blindness by the development of consecutive atrophy, or, more slowly, and even show very little if any loss of sight for a long time. It is usually bilateral, but often more pronounced on one side than the other. In many cases this is on the side of the growth. In rare cases there is progressive atrophy of the nerves without swelling. Headache, vomiting, and *choked disk* are "classical symptoms" of brain tumor, and when met with simultaneously are quite characteristic. Reversal and interlacing of color fields may also be met with (p. 1179).

Mental disturbance is very common. Dulness and stupor are most reliable evidences of intracranial growth, and especially when occurring with any of the above symptoms. The patient may be emotional or hysteric. Pseudo-apoplexy may occur as the result either of the growth or of hemorrhage taking place about it.

Convulsions are focal, either jacksonian (p. 1018) or general, depending on the location of the lesion.

Constitutional and other symptoms may include progressive weakness, loss of appetite and of flesh, amenorrhea, infantilism, pupillary changes, and changes in the pulse, respiration, etc., and possibly slight fever. In certain tumors in the basal ganglia hyperpyrexia occurs. High fever is often significant of meningeal inflammation, as in syphilitic cases.

The **focal symptoms** are of two kinds: first, those due to direct local action (irritation or compression), and second, those due to changes occurring about growth—indirect irritation, hemorrhage or softening, or merely congestion; thus can intermission or remission in symptoms be explained. The pages devoted to cerebral localization should also be consulted. The chief regional symptoms are as follows in—

(a) Tumors in the *prefrontal region*. *Headache*, not limited to the frontal region, with more or less mental impairment and drowsiness (though this is not constant by any means); and perhaps a disturbance of the sense of smell. No motor or sensory symptoms are present, as a rule, although vertigo and ataxia of the cerebellar type have been observed. The tumor may, however, grow backward, and either encroach on the motor region or cause motor symptoms indirectly. Downward growth would result in aphasia. A tendency to punning or joking (*witzelsucht*) has been noticed in some cases. Motor apraxia is sometimes present. On the side of the lesion there is often retrobulbar neuritis and rebounding pupil followed by optic atrophy, while papilledema is present on the other side.

(b) Tumors in the *motor region*. The early symptoms are irritative and, later, paralytic. The former give rise to *spasm*, which is often very localized at first, possibly in a few muscles (jacksonian epilepsy). The point of origin and direction of spread of the spasm are valuable localizing symptoms. Sooner or later destruction of the area causes *paralysis*. We may have spasm in one limb and monoplegia of the other on the same side. It may be necessary at times to decide if a growth involved the cortex primarily or is subcortical. In the former case muscular spasm usually occurs before paralysis, while in the latter paralysis appears first, the jacksonian attack not occurring until the tumor has extended to the cortex. Involvement of the left third frontal region causes motor aphasia.

(c) Tumors in the *parietal lobes*. There is usually ataxia of the limbs of the opposite side and astereognosis (pp. 1019, 1026); later on homonymous

to pressure on the motor-fibers passing through the internal capsule. The principal localizing symptom is muscular hypertonicity (p.1012). If due to apoplexy the symptoms would develop quickly; if to tumor, gradually.

(*k*) Tumors in the *cerebellum* are comparatively frequent both in children and adults. When toward the outer surface of the lateral lobes the localizing symptoms may not be marked. By pressure upon either the aqueduct of Sylvius or foramen of Magendie they often cause internal hydrocephalus (p. 1136), and the symptoms due to that condition may complicate those due to the tumor. The symptoms of growths in this region depend upon their situation, whether in either the middle or one of the lateral lobes. Tumors in the space between the cerebellum, pons, and medulla, known as the *cerebello-pontile angle*, cause symptoms similar to growths in the lateral cerebellar lobes and may also be here considered. The principal localizing symptom of cerebellar disease is asynergia (p. 1022). Its manifestations differ somewhat according to the part of the cerebellum affected.

If the *middle lobe* or vermis alone is affected, the usual symptoms are rapidly developing—choked disk, severe headache, disordered gait (cerebellar titubation), which may be compared to that of a drunken man, vertigo (p. 1063), nystagmus (p. 1054), the Romberg symptom, weakness of the muscles of the back, and sometimes of those of the legs. Occasionally, rigidity of the muscles, retraction of the head, and tetanic-like seizures have been observed. The knee-jerks may either be increased, normal, or absent, and may vary to this extent in the same patient. Palsies of cranial nerves, especially the ocular, due to pressure and usually bilateral, may occur.

Growths involving one of the lateral lobes cause symptoms that are more marked upon the side of the lesion, and the patient usually has a tendency to fall toward this side (the opposite may occur, however). When vertigo occurs, external objects move from the side of the lesion to the opposite side, the rotation of the body being in the same direction. The sixth and seventh cranial nerves are those usually affected in lesion of the lateral lobes, the paralysis being unilateral and on the homolateral side. Others may be affected. Asynergia, as shown by inability to rapidly pronate and supinate the forearm upon the side of the lesion (adiadochocinesia or adiadokokinesis of Babinski), and the straightening of the leg, after the thigh has been flexed on the body and the leg on the thigh, in a jerky inco-ordinate manner, may also be noticed on the side of the lesion. Dysmetria, demonstrated by inability to touch the end of the nose with the finger, the eyes being closed, is present on the side of the lesion. If the finger is carried past the end of the nose the symptom is termed “hypermetria.” It is important to note that in cerebellar disease the finger is not carried to the nose in the jerky, tremulous way seen in multiple sclerosis, but is carried either to one side or the other of the objective point. The head is also sometimes held inclined to the shoulder of the opposite side. Examination by the Bárány methods is important in all cases of suspected tumor of the cerebellum and vicinity, the absence of “past pointing” being especially significant of cerebellar disease (pp. 1063, 1134).

Tumors of the *cerebellopontile angle* are usually encapsulated fibromata attached to either the auditory or trigeminal nerves, usually the former. The early symptoms depend upon the cranial nerve from which the growth arises. If the auditory, there are attacks resembling those of Ménière's syndrome (p. 1064); if the trigeminal, there are neuralgic pains in the course of that nerve, with possibly sensory paralysis in its distribution. Other cranial nerves, especially the seventh, soon become affected, and the symptoms of tumor of the lateral lobe become more or less marked. The differential points between growths involving the lateral lobe, cerebellopontile angle, and pons are well given in the table of Stewart and Holmes:

(1) Tumors in the *pons* produce symptoms according to their size and location. If high up, a crossed paralysis, similar to that caused by a growth in the crus, will result. When a little lower down a motor and sensory paralysis of the arm and leg of the opposite side with paralysis of the sensory portion of the cranial nerve on the same side may result. If the lower portion is affected, paralysis of the arm and leg of the opposite side with paralysis of the sixth, seventh, and eighth nerves will occur. More or less sensory paralysis may also be present. If the cerebellar peduncles are involved, forced movements and ataxia (cerebellar type) will result. If either the nucleus of the sixth nerve or the fibers of the posterior longitudinal fasciculus is involved, there will be loss of associated lateral movements of the eyeballs toward the side of the lesion, while the power of convergence remains. The absence of nystagmus (p. 1054) when the ears are tested by the Bárány methods is indicative of an intrapontine lesion, if internal ear and auditory nerve disease is excluded.

Tumors of the medulla cause symptoms of progressive bulbar palsy (p. 1087) plus more or less hemiplegia and hemianesthesia. If the growth is small, the symptoms may be more marked on one side.

Course.—Many cases run a very chronic course. Others may have existed months or years without symptoms, and then develop suddenly, owing to hemorrhage, thrombosis, or acute softening about the tumor. Either improvement may take place or the case may speedily progress to a fatal termination.

Diagnosis.—The general symptoms are usually sufficient to warrant a diagnosis. The gradual onset and progressive character without fever, in the apparent absence of any etiologic factor, are, as a rule, enough to indicate that a tumor is present, while its location can only be determined by the focal symptoms. Recently the x-ray has been used with some success for the localization of tumors that have undergone calcareous degeneration. The possibility of the symptoms being due to a syphilitic growth or basal meningitis should be borne in mind.

The **prognosis** is always grave. Syphilitic growths are the only ones amenable to medical treatment. Cortical growths, especially if in the motor region or its neighborhood, if encapsulated, are amenable to surgical treatment. Growths in both the lateral cerebellar region and cerebellopontile angle and pituitary gland have also been removed, but the operation is more serious; tubercle may recover by the growth becoming encapsulated and calcified. Nothing can be said as to the possible duration of life. Several years may elapse between the appearance of the symptoms and their fatal termination, or death may occur suddenly.

Treatment.—In any case recourse should be had to mercury and the iodids, and this treatment should be pushed, since it will certainly benefit syphilitic cases, and it is believed to be of some value even in the non-syphilitic. Other symptoms should be met as they arise. The question of operation must be considered where medical measures have proved of no avail. If the situation of the growth is favorable and the nature of the tumor is not malignant, an operation is likely to be successful. The percentage of recoveries is increasing as the technic becomes more perfect. When the growth cannot be localized, or is in a position unfavorable for operation, much benefit may be obtained by relieving pressure by the so-called operation of decompression. Blindness, which will surely result if choked disk is allowed to persist any length of time, and the severe headache may thus be prevented.¹

¹ Frazier and Spiller, *Univ. of Penna. Med. Bull.*, September, 1906; Cushing, *Jour. Amer. Med. Assoc.*, January 16, 1909, p. 184; and *Ibid.*, January 16, 1915, p. 189.

projections, which, according to Virchow, are composed of brain substance, but in some cases are due to proliferation of the glia tissue beneath the ependyma. The enlargement may not be uniform. If due to obstruction of the foramen of Monro, one or both lateral ventricles are usually enlarged, while the third ventricle either remains of normal size or is diminished. If due to enlargement of the pineal gland, the aqueduct does not show the funnel-shaped distention. Another cause upon which considerable weight has been laid is the closure of the transverse fissure between the cerebellum and medulla. The quantity of fluid may be enormous, as much as 4 or 5 liters (5 or 6 quarts) having been recorded. The thinning of the brain substance is also remarkable when one considers that a cerebrum 5 mm. ($\frac{1}{8}$ in.) in thickness is apparently able to perform a large proportion of its ordinary psychic functions. The atrophy seems to affect particularly the white substance, especially the myelin sheaths.

In cases of the *acquired form*, unless they occur early in life, the enlargement of the skull is not very noticeable; the substance of the brain shows considerable softening; the ventricles are moderately enlarged, and, particularly in the chronic forms due to tuberculosis, are considerably roughened. The most pronounced cases are those that occur when there is a tumor in the occipital fossa which compresses the veins of Galen. Basal meningitis causing an obliteration of the foramen of Magendie is also a cause. In these cases the accumulation of liquid is slower, the brain yields more gradually to pressure, and the dilatation is more pronounced. Ordinarily, there is considerable flattening of the convolutions. In a few of these cases inflammatory changes in the ependyma have led to partial obliteration of the ventricles, particularly in the anterior horns or the lateral ventricles. Occasionally also bands of organized lymph may cross the ventricles in various directions; the liquid is of higher specific gravity and contains more albumin than in the non-inflammatory varieties.

Symptoms.—The most characteristic appearance in congenital hydrocephalus is the *globular enlargement of the head*. Upon palpation the fontanels are found to be still patulous and usually bulging, and the sutures are open. The head is usually so heavy that it cannot be held upright, but falls backward or to one side. The face appears proportionately very small. *Motility* is usually disturbed, the legs are spastic, and the child either does not learn to walk at all or only long after the usual time. There are sometimes choreic movements of the upper extremities. The *eyes* frequently show nystagmus and conjugate deviation, and often there is either choked disk or atrophy of the optic nerve. Fischer has described a *systolic murmur* that can be heard if the stethoscope is placed over the anterior fontanel. Its cause is unknown. *Convulsive attacks* are common; they are epileptic in type, and, as a rule, ultimately cause death. *Intelligence* is usually considerably impaired, and sometimes the children are idiots; more often they merely show retardation of intellectual development. Occasionally—and this even in the most pronounced cases—the intelligence is well preserved. Henoch records the case of a boy three years of age whose head was 75 cm. (29.6 in.) in circumference, and who could speak both French and German. Ordinarily, the children are quiet and apathetic, but they may be querulous. *Nutrition* is commonly seriously disturbed, the children sometimes exhibiting pronounced cachexia. They may, however, be well nourished and, to a certain degree, vigorous. The symptoms of the chronic form in adults are those of brain tumor without focal symptoms.

The **diagnosis** is ordinarily very easy. Careless observation may lead to confusion with *rachitis*, but the square shape of the head and the presence of other rachitic deformities in the skeleton should lead to a prompt recognition of the true nature of the case. At times there may be difficulty in making the

is great anxiety, and even fear, and the patients exhibit intense excitement, suffering very often with delusions of persecution by their environment, and nearly always have hallucinations, either of sight or sound. Often their minds are occupied by some subject that had previously caused them great anxiety—either disgrace, business, or other misfortune. The patient soon becomes restless, throws himself from one side of the bed to the other, and makes efforts to rise and escape from the room. The tongue is dry, the pulse rapid and weak. Petechiæ may appear upon the skin, and there is nearly always more or less fever, not rarely rising to 105° F. (40.5° C.) or even more. Rapid emaciation supervenes. There are all the objective symptoms of irritation of the brain—myosis and increased reflexes, and often hyperesthesia, although the patients pay little attention to any injury they may inflict upon themselves. This stage of excitation soon passes into one of *stupor* and *collapse*; fever may become even higher, and the pulse still more rapid and weaker. The patient lies in a condition of muttering delirium, with carphologia. All the symptoms are those of profound exhaustion: the eyes are hollow, the lips and teeth covered with sordes, and the emaciation extreme. The skin becomes dryer, and finally cyanotic, the pupils dilate, and there may be marked anesthesia. Death ordinarily occurs at the end of two or three days after the commencement of this condition. Occasionally the course of the disease is interrupted by intervals in which the patients exhibit more or less lucidity. The disease is related to an asthenic condition known as confusional insanity, which is due to the same causes, but in it the patients exhibit, in place of excitement, depression, with fear of poisoning and positive refusal of all food, mental confusion, disorientation, failure of memory, slight elevation of temperature, or, indeed, a subnormal temperature, and very rapid emaciation. It is most apt to occur in patients previously debilitated. In the paralytic form there is vasomotor paralysis with cyanosis, depression, and often stupor. From these the patient passes into an algid state, in which death occurs.

The **differential diagnosis** is frequently difficult. In many infectious diseases, particularly *pneumonia* and *typhoid*, hallucinatory delirium may develop. This, of course, must be suspected in these diseases, and it is advisable, if possible, to examine the blood in all cases of acute delirium by Widal's method. In *acute mania* fever is rare, emaciation is not so rapid, and the mental symptoms are more purely psychical. In *general paralysis*, toward the end maniacal attacks may develop, but the history of the previous existence of the disease, the presence of the Argyll Robertson pupil, and the absence of fever lead one to suspect the true diagnosis. Finally, in *delirium tremens* the fine tremor of the hands and tongue, and, if possible to obtain it, a history of recent debauch should clear up the diagnosis. The course of the disease is variable; it may vary from three or four days to as many weeks. Those cases are most rapid in which excitation is most profound.

The **prognosis** in acute delirium is most unfavorable, and is more so for men (according to Krafft-Ebing) than for women. Those cases that were previously debilitated, either as a result of chronic alcoholism, or chronic exhaustive diseases, or childbirth, are the most serious. Those that develop suddenly, and from the beginning are very severe, are also nearly always fatal; if there are no lucid intervals, or if those that occur are short and imperfect, the prognosis is graver; and the same is true of those who suffer from obstinate insomnia. In confusional insanity it is better, although serious.

The **treatment** is, of course, unsatisfactory. Calomel should be administered in the earlier stages of the disease. At the same time the temperature should be combated by cool baths or packs and an ice-bag should be applied to the head. Sleep should be obtained by the use of chloral, bromid,

Merzbacher¹). Sex is not an important factor. The disease is far more common than was formerly believed (Taylor), as the atypical forms are often not recognized.

Pathology.—The sclerotic tissue occurs especially in the white matter, though any part of the cerebrospinal axis may suffer. The cortex is rarely implicated. The spots are usually well circumscribed, gray or grayish-red in color, and on section may be level with, raised from, or depressed beneath the normal line of section according as to whether it is in the early, hypertrophic, or cirrhotic stage. The cranial nerves may be involved at their origin, the first, second, and tenth being particularly vulnerable. The medullary sheath of nerve-fibers in the affected region degenerates early, but the axons are markedly resistant. Since they are not cut off from their trophic center, secondary degeneration is rarely met with. The blood-vessels show more or less proliferation of the adventitia, and endarteritis is not an uncommon condition. Whether this vascular change is primary or secondary is unknown. Microscopically, the sclerotic areas are made up of an overgrowth of neuroglia cells and fibers and of the ordinary connective tissue. In certain cases these patches exhibit some tendency to involve special parts of the nervous system, as the lateral or posterior columns.

Symptoms.—These may be described under two headings: first, the general symptoms, or those common to all cases of the disease, and not explicable from the position of the sclerosis; and, secondly, those dependent on the locality of the lesions. The disease is always chronic, and either remissions, or one or more intermissions occur, and in some cases may extend over several years. The first evidence of the disease is *loss of power*, first in one, then in the other, lower extremity. Later, paresis develops in the upper extremity. Sooner or later other general symptoms appear—viz., tremors, nystagmus, scanning speech, increased reflexes, and optic-nerve atrophy. The *tremor* is volitional (*intention tremor*), and when the patient is at rest no abnormal movement is manifest, as a rule. On attempting to use the hands or in walking more or less coarse tremor is observed. This may be well brought out by the finger-to-nose test. The head may be similarly involved, and some inco-ordination is commonly associated therewith. As the paresis is spastic, the tendon reflexes are increased, and even ankle-clonus and the Babinski phenomenon may be present. The abdominal reflex is often absent. In addition, a certain degree of ataxia or inco-ordination of motion is present, which is independent of the tremor. The *nystagmus* is sometimes only noticeable when the eyes are moved, but usually it is constant. It is more marked in lateral than in vertical movements. *Speech* is at first slow and drawling, and of a peculiar monotonous character; later it becomes even more deliberate, and is then spoken of as scanning, each syllable being pronounced separately, with a slight rising and falling cadence. Optic-nerve atrophy is of frequent occurrence. It begins with pallor of the temporal edges of the disks, a valuable sign (Müller). It may be preceded by retrobulbar neuritis. Other cranial nerves, particularly the motor nerves of the eyes, may be affected, and at times are early symptoms. The sensory disturbances are less important than the motor phenomena. They consist of areas of hyperesthesia, particularly in the extremities, that are usually transient, and occasional tingling or numbness in the limbs. There is usually no wasting of, nor electric change in, the muscles, nor do bed-sores occur. Vertigo is usually present. The patients are usually emotional, and laugh or cry upon slight provocation; often the outbursts of laughter are wholly causeless. In other cases dementia, or even acute maniacal outbursts, are met with, but these are rare. During this stage epileptiform

¹ *Brain*, 1914, p. 341.

The most difficult differential diagnosis is from syphilis of the central nervous system. This is characterized, as a rule, by the more rapid development, the presence either of the Argyll Robertson pupil or complete pupillary immobility, the absence of the typical group of symptoms, and the response to antisyphilitic treatment. It should not be forgotten that any of the symptoms of disseminated sclerosis may be present in cerebrospinal syphilis, and that cases of the former disease may lack one or more of the fundamental symptoms, and cases will sometimes occur in which the differential diagnosis cannot be made. Examination of the cerebrospinal fluid may be of assistance, as in syphilis a marked pleocytosis, an increase of globulin, and usually the Wassermann reaction will be found (p. 1146). Arteriosclerosis may produce multiple areas of softening, causing a symptom group resembling multiple sclerosis. This, however, is more apt to occur in old people, while multiple sclerosis is more common in early middle life. Disseminated myelo-encephalitis (p. 1127) may also be mistaken. In this there may be fever and a history of previous infection. The affections known as pseudosclerosis and diffuse sclerosis may also resemble multiple sclerosis (*vide*).

The **course** usually extends over five to ten or even fifteen years, and death is generally the result of some intercurrent affection, though it may occur during an apoplectiform or convulsive attack. Rarely it is due to failure of the heart or respiration. Remissions of considerable length of time may occur.

The **prognosis** is favorable as far as life is concerned, and some improvement may even occur, but entire recovery cannot be expected.

Treatment.—Silver nitrate, mercury, the iodids, quinin, and arsenic may be tried. Rest and easily assimilable food are of prime importance.

PSEUDOSCLEROSIS AND DIFFUSE SCLEROSIS

In 1883 Westphal described a case characterized by disturbance of speech, slowness of the movements, decrease of intelligence, increased irritability, apoplectiform attacks, pronounced tremor, spasticity and increased reflexes, slight disturbance of sensation, and no involvement of the sphincters. The autopsy was entirely negative. He termed the condition *pseudosclerosis*. Since then similar cases have been reported, especially by Strümpell. Such symptoms may appear early in life and also affect more than one member of a family. They differ from those of multiple sclerosis in that usually motor weakness is not great, but spasticity is; the Babinski reflex is absent, as is usually ankle-clonus. Scanning speech does not occur, but dysarthria does. The tremor is present when the patient is at rest. In a general way these cases may resemble paralysis agitans or lenticular degeneration, and it is believed now that many of them at least are due to disease of the lenticular nucleus (pp. 1021, 1125). Many other athetoid, choreiform, and spastic conditions are probably also due to disorder of this part of the nervous system. Some of these cases may be due to *diffuse sclerosis*. Usually, however, in this condition there is spastic paralysis and dementia developing gradually. The symptoms may resemble those of paresis, but the serologic changes (p. 1148) will be absent. It may occur in young children (p. 1125) and must be distinguished from the cerebral palsies of childhood (p. 1123).

Treatment is without avail.

SYPHILIS OF THE NERVOUS SYSTEM

Syphilis affects the nervous system in two ways: (1) By a round-cell exudation involving the arteries and meninges, in which the nerve-cells and fibers are involved secondarily. This causes either the so-called gummatous meningitis, localized gumma, or obliteration of the caliber of the blood-vessels (endarteritis obliterans), with resulting apoplectiform seizures and softening. This type may be termed *meningovascular* or *exudative syphilis*. (2) By causing a degeneration of nerve-cells and fibers. This type may be termed *degenerative* or *parenchymatous syphilis*. Paresis and tabes dorsalis¹ are the common examples of this type, but progressive spinal muscular atrophy, amyotrophic lateral sclerosis, lateral sclerosis, cerebral palsies of children, epilepsy, and optic atrophy may be rarely so caused.

MENINGOVASCULAR OR EXUDATIVE SYPHILIS

Etiology.—This type comprises the cases usually termed syphilis of the nervous system, or cerebrospinal syphilis. It may be due to either acquired or hereditary syphilis. When due to the former the symptoms may appear at any time after the appearance of the chancre. The usual time is from the third to the tenth year after infection, but they have occurred while the usual secondary symptoms are present. In this connection it is important to note that during the secondary period a certain proportion of cases show the characteristic changes due to syphilis of the nervous system (p. 1146) in their cerebrospinal fluid. Such cases are those which, if not then treated as cases of nervous syphilis, will probably develop that condition later.

When due to the latter, they may appear at any time after birth, and cause symptoms similar to those following acquired syphilis. Cerebral palsies (p. 1123) and epilepsy may sometimes be so caused.

Either the brain, spinal cord, or peripheral nerves may suffer alone. Usually the brain and spinal cord are both affected. The spinal nerves are not often affected, but the cranial nerves are, and symptoms attributed to cerebral syphilis may be due to their involvement.

CEREBRAL SYPHILIS

Pathology.—The essential feature is a marked round-cell and lymphocytic infiltration of the meninges and blood-vessels. When diffuse (known as gummatous meningitis), the meninges at the base are most commonly affected, especially in the region of the optic chiasm and ocular nerves. It may, however, involve the vertex alone. When localized, a gumma results. This springs from the meninges, but may extend into the brain substance. It is a tumor and causes symptoms as such. The arteries alone may suffer, their walls being infiltrated with cells and their caliber lessened or obliterated. When such occurs, areas of softening in the areas supplied by them will be found. Gummata may develop in the adventitia, causing globular or ovoid swellings. Macroscopically, gummatous meningitis has a gelatinous, yellow appearance; in places there may be connective-tissue formation.

Symptoms.—A symptom frequently present before the development of others is headache. This is usually very intense and worse at night. In connection with this there may be somnolence, sometimes amounting to stupor, during the day. If the lesion affects the vertex, epileptiform convulsions may occur. If the lesion is localized, these may be of the jacksonian type. When the base is involved, cranial nerve palsies occur. Those most

¹ In their early stages at least these two diseases would seem also to belong to the exudative type.

commonly affected are those which move the eyeball (third, fourth, sixth). At first these palsies may be transient, appearing and disappearing from time to time. If the exudation is in the region of the optic chiasm, symptoms simulating those of pituitary tumor (p. 1132) may be caused. Optic neuritis or beginning atrophy is a frequent symptom and may be a very early one. It is well to have an ophthalmoscopic examination made from time to time in patients who have contracted syphilis. When the blood-vessels alone are diseased, apoplectic attacks, usually due to thrombosis, may occur. Such an attack in a young person, in whom embolus or a previous attack of one of the infectious fevers can be excluded, is usually due to syphilis. The symptoms of gumma depend upon its location, and are practically those of brain tumor. Diffuse meningitis may, however, be associated. Hypochondria and either mental depression or excitement may be due to syphilis.

SPINAL SYPHILIS

Pathology.—The lesions are similar to those found in cerebral syphilis.

Symptoms.—These may be those of either acute transverse or disseminated myelitis (p. 1093), or if the meninges are involved, those of meningo-myelitis. The Brown-Séquard syndrome (p. 1034) also occurs, especially if the lesion is either a gumma or small area of softening. A form of spastic paraplegia, known as Erb's type of syphilitic spinal paralysis, frequently occurs. This is characterized by slowly increasing stiffness and weakness of the legs. The gait is of the ataxic paraplegic type (p. 1108), the deep reflexes are increased, and the Babinski reflex can be elicited. More or less difficulty in either passing or holding the urine is present. Sensory symptoms are not prominent, although pain in the sacral region and paresthesia in the legs may be complained of. The lesion consists of thrombosis occurring in the vessels of the lower dorsal region of the cord, and involving principally the posterior columns and posterior part of the lateral columns. Gummatous meningitis involving the posterior roots may cause symptoms simulating tabes. Localized gumma causes symptoms similar to those of spinal tumor.

CEREBROSPINAL SYPHILIS

This consists of various combinations of the symptoms of cerebral and spinal syphilis, and is probably the most common type.

SYPHILIS OF THE PERIPHERAL NERVES

Without involvement of either the brain or cord this is not common. Either isolated primary atrophy of the optic nerves or optic neuritis may occur. These may be early symptoms, as may also be involvement of the auditory nerve. Other nerves may be the seat of a round-cell infiltration, which causes paralysis of the muscles or skin areas supplied by them. Multiple neuritis has been described.

DIAGNOSIS

Syphilis may simulate any of the various organic diseases of the brain and cord. There is usually, however, something atypical in the development of the symptoms. There are also apt to be in the early stages transient symptoms. Headache of the type described (p. 1144) is a frequent prodrome, as may be vertigo, transient paralyses, especially of cranial nerves, epileptiform convulsions, somnolence, etc. Such symptoms may precede apoplectic attacks due to syphilitic disease of the arteries. Those who have been infected should have the eyes examined at intervals for signs of either optic neuritis or atrophy, and also the ears, for disease of the auditory nerves. The development of serologic tests has been of great help. In this connection

Lateral sclerosis, amyotrophic lateral sclerosis, progressive spinal muscular atrophy, and some forms of mental deterioration in children may be sometimes so caused.

GENERAL PARALYSIS OF THE INSANE

(*General Paresis; Paresis; Chronic Diffuse Meningo-encephalitis; Dementia Paralytica*)

Definition.—A chronic disease involving the cerebrum, spinal cord, and the meninges, and characterized by a gradual loss of power, tremors, and progressive mental decay.

Pathology.—The intima and adventitia of the blood-vessels undergo proliferative changes, and the perivascular spaces are dilated and contain an excessive quantity of fluid, also cellular elements. Obliterative endarteritis occurs also. Atrophy and degeneration of the cerebrum are met with, chiefly involving the cortex, particularly that of the frontal or parietal regions and the anterior basal region. The ventricles are dilated and the ependyma is granular. The membranes are thickened and opaque, and adherent to the surface of the convolutions, so that the cortex is torn upon their removal. Hemorrhage may take place into the subdural spaces, and may vary in amount from a mere stain to the formation of a pseudomenbrane.

Secondary sclerotic and degenerative changes are found in the posterior and pyramidal tracts of the cord in most cases.

Etiology.—As in locomotor ataxia, a history of syphilitic infection is obtained in a large majority of all cases. Noguchi and Moore have demonstrated the *Spirochæta pallida* in all the layers of the brain cortex except the outer one in 12 cases out of 70 examined.¹ The condition occurs more frequently in men than in women, and usually between the thirtieth and fiftieth years. Business or domestic troubles, and, in fact, great anxiety of mind from any cause, trauma, also venereal or alcoholic excesses serve more or less directly to induce the disease. The white races, Hebrew and Caucasian, seem to be especially predisposed, the yellow and black races less so, although it is occasionally observed among the negroes of America. It is undoubtedly increasing in frequency.

Symptoms.—The **prodromal stage** may last for months, or the onset may be sudden with an apoplectiform or epileptiform seizure. When the former is the case, neurasthenic symptoms are frequent. The symptoms are both mental and physical, either of which may appear first and exist alone for some time, or they may be contemporaneous in point of onset. As a rule, some *alteration of the character* and demeanor of the patient is the first evidence of the trouble. The patient suffers from insomnia and is generally restless, as well as incapable of sustained effort. He will be forgetful and perhaps careless where he was formerly careful and attentive. The sexual desire may be excessive. The *ego* will figure prominently in his sayings and doings. Sometimes he is hypochondriacal, sometimes exalted, and feels strong and competent. Among the physical signs are frequent twitchings and *tremors* of the facial muscles, particularly of those about the mouth and the tongue. Tremors of the hand and arm seriously interfere with writing; tremor of the lips and tongue renders the *speech* thick, blurred, and hesitating, and syllables are omitted from words, or even whole words lost from sentences; and the *pupils* are frequently unequal and fail to react to light, but do in convergence and accommodation (Argyll Robertson pupil), primary optic atrophy may also be present. The tendon reflexes may either be diminished, lost, or exaggerated. The gait may be ataxic, in fact, all the symptoms of tabes may be associated with paresis (taboparesis). These symptoms extend over a variable period, with one or more remissions as

¹ *Jour. Amer. Med. Assoc.*, March 29, 1913, p. 1002.

in the earlier stages, the first evidence of the disease being paresis in the lower extremities. The tremor, too, is volitional, the speech is scanning, and nystagmus is present. Mental phenomena develop late if at all, and are not expansive in nature.

(2) In *paralysis agitans* there are frequently no mental changes, and in any case they consist of nothing more than dulness. The characteristic attitude and gait; the tremor when at rest, which sometimes ceases on movement; the speech, which is hesitating at first, then hurried; the high-pitched voice; the absence of pupillary changes—all mark *paralysis agitans*. Remissions are uncommon.

(3) *Cerebral syphilis* may also simulate paretic dementia. In cerebral syphilis the tremor may or may not be present, but no speech-defect occurs; and attacks of severe headache are frequent and usually severe. Palsies of cranial nerves and complete immobility of the pupils are more liable to be due to syphilis. The condition often passes into dementia, but the peculiar expansive delusions of paresis rarely, if ever, occur. Mott states that in syphilitic pseudoparesis the lymphocytes in the cerebrospinal fluid disappear under antisyphilitic treatment, but in true paresis they do not. Plasma cells are not present in the fluid in syphilis, and the lymphocytes are usually much greater in number (80 to 2000 per cubic millimeter) than in true paresis (8 to 78 per cubic millimeter). (See also p. 1146.)

(4) The characteristic physical symptoms will distinguish the two (p. 1148).

(5 and 6) Both of these poisons may cause symptoms resembling those of paresis. The history and occurrence of hallucinations, which are very uncommon in paresis, will often serve to differentiate the two conditions. Often, however, the diagnosis can only certainly be made when the patient recovers, which he will not do if he has true paresis.

(7) The absence of mental symptoms and the occurrence of atrophy of the tongue, paralysis of the vocal cords, etc. (p. 1067), distinguishes *bulbar palsy*.

(8) Patients with *chronic mania* do not have the peculiar physical symptoms of paresis, and there will usually be a history of a previous attack of acute mania. Spells of acute excitement may, however, occur during the course of paresis.

The presence of an increase of the lymphocytes in the cerebral spinal fluid and the Wassermann test or some of its modifications will distinguish paresis from any of the above, excepting syphilis (*supra*). There is also a possibility that a patient having alcoholic pseudoparesis may have had syphilis, which renders the examination of the cerebrospinal fluid of importance.

The **prognosis** is gloomy and recovery never occurs. The tendency is toward a fatal termination in from two to three years. In rare cases the progress may be slow or remissions may delay the termination for several years longer.

Treatment.—Drugs are of no value in a curative sense. Proper treatment may cause more frequent remissions and their longer duration. The use of arsphenamine, administered either intravenously or by the Swift-Ellis method (p. 1154), may be of service in incipient cases. Bromids, morphin, chloral, or, still better, sulfonal, trional, or hyoscin, may be used in combating the insomnia and attacks of delirium. These cases cannot be properly cared for at home; indeed, their removal to an asylum is generally imperative. The tendency to bed-sores must not be forgotten, and continuous rest in bed must, therefore, be postponed as long as possible.

TABES DORSALIS

(Locomotor Ataxia; Posterior Sclerosis)

Definition.—A disease, primarily of the posterior nerve-roots, with consequent secondary degeneration of the posterior columns, also degeneration of peripheral nerves and those of special sense, particularly the optic. It is characterized by more or less inco-ordination of movement, various sensory and trophic disturbances, and impairment of the special senses.

Etiology.—Syphilis is probably the exclusive cause. Whether the tabes occurs because the individual is predisposed or because the syphilitic virus in these cases has some peculiar predilection for the central nervous system is not determined. Some interesting evidence has been collected in favor of the latter view. There may be a history of injury, severe prolonged muscular exertion, dissipation, or sexual excess. Race appears to be of some importance, but an increasing proportion of cases is found among negroes and Jews, who were formerly considered partially immune. Males are more liable to the disease than females in the proportion of 10 to 1. About 75 per cent. of all cases commence between the ages of thirty and fifty. It may occur in childhood due to hereditary syphilis.

Pathology.—Macroscopically, it may be observed: 1. That the posterior roots are more or less atrophied and grayish in color.

2. There is a thickening and adhesion of the spinal membranes, with some degree of congestion, particularly noticeable in the posterior region (not a constant change).

3. There is a slight change in the shape of the cord, and the affected regions assume a grayish tint. Change of color is well seen after the cord is hardened. Microscopically, the first changes are found in the posterior roots, usually the lumbar, followed by sclerosis in the column of Burdach and zone of Lissauer, also most marked in the lumbar region and localized at the point of entrance of the root-fibers. Higher up the columns of Goll will be found involved. The fibers coming from the posterior roots to join the column of Clark are also sclerosed, but as the cells, as a rule, are not destroyed, the direct cerebellar tract is rarely involved. In advanced cases sclerosis of Gowers' tract may also be observed. While the disease usually first affects the lumbar nerve-roots, either the sacral, upper thoracic, cervical, or bulbar nerve-roots may be first involved, in which event the cord changes above noted will be found more marked in one of these respective areas. In addition to the cord changes degeneration of peripheral spinal nerves and of cranial nerves and their nuclei, especially the ocular, may be found. Less marked changes may also be found in the anterior nerve-roots.

Nageotte's views as to the pathogenesis of the disease are now those most generally accepted. In brief, he believes that tabes is the result of a local affection of the spinal roots at the height of the "nerfs radiculaires"—i. e., that part of the root from its entrance into the dura mater to the spinal ganglion. It consists of an endo- and perineuritis with interstitial and parenchymatous changes, due to a mild but chronic syphilitic meningitis. The "nerf radicaire," being a channel for the lymph circulation in the central nervous system, is believed to be a spot more vulnerable to toxic and irritating material circulating in the cerebrospinal fluid. This is further intensified by the fact that the nerve-fibers lose their neurilemma sheaths as they pass through the pia, and, hence, when damaged by the meningeal exudation, have no power of regeneration. The degeneration found in the cord is, hence, secondary, the nerve-fibers being separated from their trophic centers, the posterior ganglion.

In addition to changes in the nervous system, certain cases present some

morbid condition of the osseous system, consisting of erosion of the intra-articular cartilages and atrophy and absorption of the bony articulating surfaces.

Symptoms.—These may be grouped into various stages: the prodromal, preataxic, ataxic, and paralytic. The *prodromal stage* may extend over a number of years, the symptoms are slight, and often make very little impression upon the patient. They consist of occasional pains, usually in the legs, of transient disturbances of the ocular muscles leading to ptosis, diplopia, etc., occasionally of slight diminution of vision, most noticeable at night, of more or less pronounced impairment, very rarely exaltation, of sexual power, and neurasthenic symptoms. The symptoms become characteristic only in the *preataxic stage*. The pains in the legs become more frequent and assume the typical fulgurant or lancinating type; that is, a stabbing or boring sensation, shooting along the limbs and lasting for a brief interval of time. There is often numbness or anesthesia of the extremities and the patient feels as if walking on cotton. The pupils give the Argyll Robertson phenomenon, there is permanent myosis, nyctalopia, and the paresis of the eye muscles may be still present or may have disappeared; primary atrophy of the optic nerve will also frequently be found. There is usually some disturbance of motion, chiefly manifested at night, and ataxia may be revealed by the finer tests (having the patient hop backward on one leg). The patella and Achilles' jerks are diminished or absent. There is now distinct impairment of sexual power and difficulty in urination. Martin has described a peculiar loss of tone and muscle sense of the rectal sphincters. The sensory symptoms belong to this and the following stage.

The dominant symptom of the *ataxic stage* is the inco-ordination of movement. This gives rise to the *ataxic gait*. The legs are kept far apart and are lifted higher than is necessary from the ground, they are brought down violently, and the gait is of a peculiar stamping, irregular, slightly staggering character. Walking without the aid of a cane soon becomes impossible, and the feet are carefully watched. Ataxia of the arms occurs later and is manifested by difficulty in grasping objects or in accomplishing finer co-ordinated movements. Ataxia of the lower extremities may be tested by directing the patient to touch with his toe an object held above it, or, when lying down, to place the heel of one foot upon the knee of the other; of the upper limbs by directing him to touch rapidly the tip of the nose with the forefinger, or to spread the arms apart and bring the forefingers rapidly together. Loss of station, or *Romberg's symptom*, is tested by directing him to stand with the feet close together and to close the eyes. The swaying of the body will vary from several inches in either direction to falling over. The reflexes are now completely abolished, and there may be some wasting of the muscles, and marked muscular hypotonia, causing relaxation of the joints, will frequently be found. The sphincters are involved, there is often difficulty in voiding the urine, associated with incontinence, and, as a result of careless catheterization, cystitis is often acquired. The facial expression is peculiar, the pallor, drooping lids, small pupils, and deep lines give an impression of weariness, dulness, and apathy that is quite characteristic.

The *sensory symptoms* are various: in addition to the fulgurant pains, there may be visceral crises, characterized by sudden severe pain and disturbance of function. The most common seat is the stomach, and the crises are associated with vomiting of acid material. Crises may also involve the larynx, liver, kidneys, clitoris, bladder, and eyes. The latter is associated with pain, lacrimation, and blepharospasm. Diminished sensation affects the organs, nerves, and areas of the skin. There is loss of sensation in the testicles or

breasts, and severe blows in the pit of the stomach cause no distress. *Biernacki's symptom*, loss of sensation in the ulnar nerve when pressed upon at the elbow, is present. The same phenomenon can be observed in the peroneal nerve, where it winds around the head of the fibula. These may be early symptoms. Areas of analgesia or hypalgesia, usually segmented in type, can be detected upon the trunk or upon the extremities. Astereogenosis, or the loss of the ability to recognize objects, may be present on one or both sides, or the stereognostic sense may not be impaired. The *girdle pain* is a feeling of constriction about some part of the trunk that may be very uncomfortable. *Trophic changes* are of various kinds, painless loosening of the teeth; *arthropathies*, characterized by enlargement and erosion of the joints, which are painless; fragility of the bones leading to spontaneous fracture; herpes and perforating ulcer of the foot. The *paralytic stage* inaugurates the termination of the disease. Locomotion becomes impossible, or can only be accomplished with the aid of two canes, loss of control over the bladder is complete, the patient is querulous or even demented, and muscular wasting and bed-sores may appear. In either this or the ataxic stage the optic nerve may atrophy until blindness results, and this is often associated with a remarkable improvement in the ataxia that is at present inexplicable (ocular tabes). It is important to remember that mental symptoms may be present, as tabes and paresis (p. 1147), may be associated (taboparesis). Death usually occurs as a result of infection, either through the bladder or lungs, more rarely as the result, apparently, of exhaustion.

Atypical cases are not rare. In *cervical tabes* the ataxia may appear first in the upper extremities and may be more severe in them, and the fulgurant pains may be limited to them. Laryngeal crises are more common in this form, and neuralgic pain in the course of the fifth nerve may be present. Certain classical symptoms may not appear in the entire course of the disease. In sacral tabes the knee-jerks may be present, while the Achilles jerks are lost. It is well in all cases to have Wassermann tests made with both the blood-serum and cerebrospinal fluid, and to examine the latter for an excess of lymphocytes and the globulin reaction. The cell-count may vary from normal (indicating usually that no active process is in progress) to 95 or more. Cases in which the latter occurs are usually those in which there is an active meningeal irritation. In such cases the Wassermann test is usually positive in both serum and cerebrospinal fluid and the globulin reaction is present. In other cases the Wassermann test may only be positive with the serum and the globulin not in excess. Old cases in which the active process has subsided may give a normal serology. In doubtful cases Lange's colloidal gold reaction (p. 1146) and Noguchi's luetin test may be used.¹

Course.—The earliest symptoms are usually observed from five to twenty years after the syphilitic infection. Rarely the disease runs a very rapid course. The preataxic symptoms—pain, loss of knee-jerk, Argyll Robertson pupil, with or without ptosis and diplopia—may only exist a few weeks before inco-ordination develops. The latter will then reach its acme in twenty to thirty days. This is very unusual, however. As a rule, the first or preataxic stage extends over a period varying from months to even as long as twenty-five years. In some cases the first stage may be unnoticed. The second or ataxic stage—that of inco-ordination—is generally slowly progressive, finally reaching a point at which it remains; rarely, more or less improvement may follow. The final stage in a few cases is only reached when the patient has become paralyzed and bedridden.

¹ *New York Med. Jour.*, August 22, 1914, p. 349.

Diagnosis.—This is readily made when we have a combination of the absent knee-jerk, fulgurant pains, and the Argyll Robertson pupil.

Differential Diagnosis.—*Peripheral Neuritis.*—The symmetric distribution of symptoms, tenderness in the muscles and over the nerve-trunks, more weakness and wasting, pain (not fulgurant in type), absence of the Argyll Robertson pupil, and the history of the case are sufficient. *Alcoholic*, diabetic, and, more rarely, *arsenical neuritis* give rise to a condition closely resembling true tabes, in that there is the loss of knee-jerk, often sharp pain, and inco-ordination, though the latter symptom is never as marked as in advanced tabes. The gait, however, is totally different, and consists of the high “steppage” gait described in the discussion of Peripheral Neuritis.

Ataxic Paraplegia.—Apart from the absence of pain and anesthesia, inco-ordination is followed by a spastic condition. The knee-jerk is much exaggerated, ankle-clonus develops, and the Babinski reflex is present.

Cerebellar Disease.—The inco-ordination does not resemble that of ataxia; optic neuritis is present; also headache and vomiting appear in well-marked cases. The knee-jerk is usually present.

Ataxia may be present in *combined sclerosis*, due to anemia and infections (p. 1109), as lesions of the posterior columns are present. In this disease the Argyll Robertson pupil is absent. While paresthesia is pronounced, the characteristic pains of tabes are not complained of. The Babinski reflex will also usually be found. The history of the onset and course of the disease also differs.

Cerebrospinal syphilis may simulate tabes. Examination of the cerebrospinal fluid will usually show a much higher lymphocyte count (80 to 2000) in ordinary forms of cerebrospinal syphilis than tabes (p. 1152). The Wassermann test is positive in a larger percentage of cerebrospinal fluids and the globulin reaction greater. Argyll Robertson pupils, visceral crises, and arthropathies do not occur. Pupils that do not respond to either light or convergence are common.

The crises may be mistaken for *disease of the various organs involved*. Repeated attacks of acute pain, tabetic in character, and particularly in adult males, should, however, excite suspicion, and an absence of the knee-jerk and other characteristic evidences will always be present in ataxia.

When the chief lesion is in the dorsal region the pain may be mistaken for that of *spinal caries* or even *neuralgia* or *rheumatism*. From caries it may be differentiated by the fact that in vertebral disease the pain is more or less localized, and that it is much increased by movements. Moreover, the other symptoms of ataxia are wanting—*e. g.*, ocular troubles, inco-ordination, and absence of the knee-jerk. The latter point also holds good in cases of rheumatism and intercostal neuralgia. For the diagnosis from hereditary ataxia, *vide* p. 1108.

Prognosis.—The outlook is serious, but if the diagnosis is made early and modern methods of treatment employed there is fair hope of improvement. Complete recovery is unusual, but occurs in cases of true syphilis which simulate tabes. The disease does not cause death, at least for a long time. Cases in which the cell-count is high (p. 1152) are, as a rule, more amenable to treatment.

Treatment.—Rest (first suggested by Weir Mitchell) is imperative when the patient commences treatment, and especially when pain is an early symptom, massage and electricity being employed meanwhile to keep up the tone of the muscles. The bowels should be moved daily, and the urinary functions especially looked to. In certain cases catheterization is necessary. The patient should then be taught, first, what surgical cleanliness means; and second, how to use the instrument. Urotropin in doses of gr.

v—0.3, three or four times daily, is a valuable prophylactic against cystitis. Counterirritation along the spine and suspension are useless. The diet should not be heavy, and if gastric crises occur special care should be taken in this direction. Vigorous antisyphilitic medication should be employed in all cases where the serologic changes peculiar to syphilis (p. 1154) are found. In old cases in which these tests prove negative such treatment is not advisable, but it should consist of measures to improve the general health and nutrition. If specific medication is used it should at first consist of arsphenamine, given intravenously. These injections should be repeated until six or eight are given at intervals of a week. Mercury should be used during the intervals and for a period of six weeks thereafter. After this the spinal fluid should be examined and if the treatment is efficacious the cells should be less in number and the Wassermann reaction weaker or absent. If this result has not been obtained, another course of similar treatment should be given. Symptomatic improvement may, however, be present. If there is then no improvement in the serologic tests it is well to omit the use of arsphenamine for a month or two, although mercury may be continued. After this another course of arsphenamine intravenously may be given or intraspinal injections by the Swift-Ellis method tried.¹ Arsphenamine has been found to relieve the pains even when no other benefit resulted. Optic atrophy is not a contraindication, in fact, it may be benefited. Nephritis and advanced arteriosclerosis are. Arsenic, chlorid of gold and soda, and nitrate of silver seem to have some influence upon the course of the disease.

The fulgorant pains, or those of the various crises, are occasionally so severe as to require codein, or even morphin, though the use of the latter agent is always to be postponed until other means are exhausted. For the former, rest in bed and bandaging the limbs may be useful. Antipyrin or salol and phenacetin may also be tried. Gastric crises may be relieved by cerium oxalate and small doses of cocain or carbolic acid. Morphin is usually required. In some cases the crises are so severe that even this fails to give relief. The cutting of the posterior roots (seventh to tenth) of the dorsal nerves (rhizotomy) has been efficacious in the relief of intractable gastric crises.² In any case the patient should live a simple, regular life, avoiding excesses of all kinds, and particularly sexual and alcoholic indulgences.

Electricity is of service in relieving paresthesia and pain. For this purpose either a rapidly interrupted faradic, static spark or high-frequency current applied to the extremities may be tried. Hydrotherapy is a serviceable measure if judiciously employed. Neither cold nor hot baths are free from deleterious effects, but tepid baths (80° to 90° F.—26.6°–32.2° C.), combined with gentle friction of the body surface, are signally useful.

Recently it has been discovered (Frenkel) that the *ataxia* can be greatly improved by systemic exercises designed to train the muscles in co-ordinated movements. The important points are to avoid fatigue and irritation, and to increase gradually the complexity of the tasks.

¹ *Archives Int. Medicine*, September, 1913, p. 331; *Jour. Amer. Med. Assoc.*, January 17, 1914, pp. 183 and 187; *Amer. Jour. Med. Sci.*, November, 1914, p. 693; *Amer. Jour. Med. Sci.*, October, 1916, p. 90; *Jour. Nerv. and Ment. Dis.*, May, 1918, p. 343.

² Frazier, *Amer. Jour. Med. Sci.*, January, 1913, p. 116.

VI. GENERAL AND FUNCTIONAL DISEASES

INFANTILE CONVULSIONS

(Eclampsia Infantilis)

Under this term are grouped a number of conditions, with convulsive attacks as the common symptoms.

The **causes** are: 1. Organic brain lesions (pp. 1124 and 1127). 2. Neuro-pathic tendency, that is manifested later as hysteria or epilepsy. 3. Emotional disturbances, as fright. 4. Rickets, in about 30 per cent. of all cases. 5. Acute infectious disease, especially as an initial symptom of pneumonia, and more rarely of scarlet fever, small-pox, and pernicious malarial infection. 6. Inflammation of the serous membranes, as meningitis, where the relation is direct, or pleuritis or peritonitis. 7. Kidney disease, in which they are uremic. 8. Peripheral irritation; dentition has long been supposed to be a chief factor in their causation, but it is now believed that the chief cause is the presence of rickets. Intestinal parasites have also been found, particularly the *Ascaris lumbricoides*, and the convulsions have ceased after their expulsion. 9. Debility, especially that resulting from gastro-intestinal disorders.

Pathology.—The pathologic changes may be divided into two groups: (1) Those bearing an etiologic relation to the convulsive attacks, and (2) those that are merely consecutive. Among the former are meningeal bleeding, tumor, gliosis (either hypertrophic or atrophic), and hydrocephalus. Then there are general conditions that seem to predispose to this condition or, at any rate, are frequently associated with it, such as rachitis. The consecutive lesions are hemorrhages into the meninges or into the substance of the brain and the spinal cord, an increase in the amount of cerebrospinal fluid, and congestion of the pia or the substance of the brain.

The **symptoms** of the attack vary according to its intensity. In the most severe form they resemble in all respects those of an epileptic seizure. At first the eyes deviate upward or to one or the other side, and the gaze becomes fixed and staring; next there are *twitchings of the muscles* of the face, sometimes slight and limited to one side, and sometimes general, often involving the muscles of mastication and giving rise to trismus or gnashing of the teeth. Next there are *tetanic contractions* of the extremities, the fingers being strongly flexed, the hands flexed upon the arms, and the feet in the position of *pes equinus* or sometimes in the dorsal flexion, and both legs and arms rigidly extended. Often the muscles of the trunk are involved, and there is either *opisthotonos* or respiratory cramp, with excessive hardness of the abdominal muscles. This rigid condition is interrupted at brief intervals by sudden *twitchings*, or occasionally the convulsion becomes clonic instead of tonic, and there are repeated extensions and contractions of the extremities, shaking of the head, and quivering of the whole body. As a result of the respiratory cramp, *cyanosis* rapidly develops and may reach an extreme degree. The forced respirations give rise to a foam that collects about the lips, and is often mixed with blood from the bitten tongue. Urine is often, and feces occasionally, passed involuntarily. In nearly all cases unconsciousness is complete. Many of the slight attacks are accompanied by a cry or by an attack of screaming. The tetanic state usually lasts for a minute or two; then there are a few clonic movements, relaxation becoming rapidly complete, and the spasm is ended by a few deep respirations. The child may return to consciousness, although it is usually drowsy or stupid, or it may pass into a deep sleep from which it cannot be aroused. Often in the latter condition attacks will recur at irregular intervals, and sometimes a single attack may continue for some time, although

from time to time there are slight twitchings followed by partial relaxation (*status eclampticus*—Lewis). The attack may come on suddenly, or, as is more frequently the case, it may be preceded by a period of restlessness and irritability. A milder form of the spasm consists of sudden fixation of the eyes, slight twitching of the body, and a peculiar dusky pallor that passes away in a few moments. In other rare cases consciousness may persist, although the patient is aphasic. Laryngismus stridulus is an analogous condition (*vide* Diseases of the Larynx, p. 513).

The **diagnosis** of the condition is very easy. The recognition of the cause, however, is very important and often difficult. Every case should first be examined for rickets, and then the gums should be investigated; also the condition of the child's nutrition and the presence of symptoms of gastric or enteric irritations. If fever exists, it is important to discover its cause. The character of the convulsion is often of value in distinguishing between the idiopathic or reflex type and that due to organic brain disease. Convulsions beginning immediately after birth, or an injury, either persisting or else disappearing gradually, are probably caused by meningeal hemorrhage (p. 1123). An attack of a jacksonian type would, of course, indicate the presence of a focal lesion; and if this be a tumor, there will probably be bulging of the anterior fontanel, severe headache, and the ophthalmoscope will reveal a neuroretinitis. If, after the attack, pareses or paralyses are present, a focal lesion is still more likely. Hydrocephalus is usually recognized with ease. Some cases exist, however, in which it is impossible to discover any adequate cause.

The **prognosis** varies according to the etiology. In cases with organic brain disease it is unfavorable as regards cure. In those forms that precede epilepsy or functional nervous diseases the spasms usually disappear after the first dentition, and the patients appear to have recovered for a time. In those, however, in whom the symptoms are due to some peripheral irritation or to rachitis, the outlook is fair, although even these now and then develop into permanent epilepsy. The convulsions themselves are either often immediately fatal, or so exhausting to the patient that he succumbs readily to the disease that produced them. In these cases the prognosis depends upon the frequency and severity of the attacks, death usually terminating those in which the status eclampticus has been established. The prognosis for ultimate cure depends also in part upon the length of time that the condition has existed; if but for a short time before an arrest has been established, recurrence is much less likely. Gowers, however, says that even after a year's duration permanent cure may sometimes be obtained. The possibility of a beginning epilepsy must be considered.

The **treatment** naturally falls into two parts—that of the attack and that of the interval. Unquestionably, the most efficacious antispasmodic that we possess for this condition is chloroform. A few drops may be put upon a handkerchief and held carefully over the nose and mouth of the little patient. A very small quantity usually suffices, and the effect is almost instantaneous. In addition to this, chloral and the bromids may be given by the rectum, and it is often useful to add to these one of the coal-tar antipyretics, particularly antipyrin. Formerly hot mustard-baths were much in favor, but unless they do good at once they are not likely to be of any use. In a very obstinate case under my care they were absolutely valueless, and were replaced by momentary immersion in ice-cold baths and vigorous friction, which seemed to act very favorably. If any known source of irritation is present, as an overloaded stomach, it should be relieved at once, if possible, by the stomach-tube or an emetic. An enteritis may be temporarily benefited by an enema or by a moderate dose of calomel. The treatment during the interval depends upon

the nature of the cause. If rachitis exists, it should be treated according to the principles laid down in my discussion of this disease. If dentition is suspected, the gums may be lanced, but this should only be done when they present distinct signs of irritation. Gastro-intestinal disorders of any kind should be relieved as soon as possible, and intestinal parasites must be expelled. In infectious diseases the convulsions usually disappear after the initial stages, and require no further attention. In organic brain disease, providing it be not syphilitic in nature, very little can be done. Finally, in those cases in which no cause can be discovered bromids are the only resource, and should be given in sufficient doses: from gr. iiij to v (0.194–0.324) per day to children of six months, and from gr. v to x (0.324–0.648) to those between six and sixteen months.

EPILEPSY

Definition.—A condition characterized by attacks of unconsciousness, with or without convulsions. We are scarcely justified in speaking of epilepsy as a disease. It seems, in reality, to be a symptom, though in many cases (the so-called idiopathic cases) we do not know the underlying cause. The type of cases in which the unconscious period is very brief (momentary), with no convulsion following, or at most but a slight rigidity, is termed *petit mal*. The more pronounced type, with prolonged unconsciousness and severe general convulsions, constitutes *grand mal*. That form first described by Hughlings Jackson in which the convulsion is localized, and in which unconsciousness may or may not occur, is called *jacksonian*, *focal*, or *cortical epilepsy* (p. 1018).

Pathology.—Epilepsy is a symptom, and the inevitable question must be, "Of what?" In certain cases this can be answered (in the organic cases), since the lesion is demonstrable; but in others (functional or idiopathic) there is no demonstrable lesion. Among the causes of the former are brain tumors, meningitis, traumatism inflicted either at birth or subsequently, atrophy and sclerosis, vascular disturbances, syphilis, and toxemia, both autogenous (which may be associated with abnormal position of different parts of the gastro-intestinal tract) and exogenous. Peripheral lesions too may give rise to it. Little can be said about the idiopathic variety, we can only enumerate causes; we do not know in any case how these act, and we do not know the ultimate pathology. Many writers apply the name "epilepsy" only to the idiopathic form, while others include all apyretic affections characterized by the occurrence of fits, whether of centric or peripheral origin. Brown-Séquard believes that the distinction between the various kinds of convulsions is artificial, and that the correct classification should be based on the knowledge of the cause.

Etiology.—The causes are (1) *predisposing*, (2) *exciting* or *determining*. Among the former, which refer particularly to the idiopathic form, are—

(a) *Age.*—Most cases develop during childhood. It has been said that when the attacks first appear after thirty-five years that they are not idiopathic.

(b) *Heredity.*—Family neuroses, such as insanity, hysteria, chorea, etc., are common, but it is decidedly more the exception than the rule to find either parent epileptic.

(c) *Alcohol.*—The causal relationship between an abuse of alcohol by the parents and epilepsy seems rather pronounced. Féré says that of 594 epileptics examined by him, 258 had parents who were hard drinkers. Echeverria refers to 572, 257 of which he believed could be traced directly to the abuse of alcohol.

(d) *Syphilis* does not predispose. When it gives rise to changes in the brain and cord, which in turn cause epilepsy, it is in reality a determining cause.

(e) *Eye-strain* is no longer regarded seriously as a predisposing influence.

The **exciting or determining causes** are traumatism to the head with or without actual lesion of the skull or brain, mental shock, various morbid conditions of the membranes of the brain or of the brain proper (*e. g.*, after hemiplegia) or peripheral irritation (dentition, worms, a cicatrix, an adherent prepuce, etc.). Not a few cases are dependent upon toxic substances in the blood, as in uremia and lead-poisoning. Excessive indulgence in alcohol or overeating often precipitates the attack. Intestinal stasis must be considered. Great emotion and nervous shock (fright) seem to be exciting causes in some cases. Pituitary insufficiency and excessive thyroid secretion have been mentioned as causes. There are cases of bradycardia in which epileptiform attacks occur (Stokes-Adams' disease). Cerebral arteriosclerosis may cause the epileptiform attacks that occur in old people.

Symptoms.—Petit Mal.—In this condition the majority of cases belong to the following type: The attack begins suddenly; perhaps while talking to the patient his expression suddenly becomes blank, the face pales, the pupils dilate, and he is evidently not conscious. In a moment or two he gathers his scattered senses and picks up the thread of the conversation. Very often he is not cognizant of any lapse of time or has but a vague idea that something has occurred. If carefully observed, fine clonic movements may be detected in many cases, it may be of the facial muscles or of the hands. Convulsions never occur, the dominant feature being the unconsciousness. On regaining consciousness the patient may act strangely and appear dazed; it is seldom, however, that he falls in attacks of this kind. Occasionally a peculiar dreamy state takes the place of an ordinary attack, or the individual may be the victim of imperative ideas. Falret has described a condition (*épilepsie larvée*) known as masked epilepsy, in which maniacal outbursts or explosions of passion occur.

Grand Mal or Haut Mal.—In many cases some subjective symptom precedes the actual attack. In its most specialized form it is termed an *aura*, and includes any phenomenon, motor and sensory, that ushers in an attack. While the aura differs in different cases, it is almost invariably constant in the same case, so that one will have a subjective sensation of sound, another of light, either flashes or colors, etc. There are other signs that occasionally antedate an attack, and which may or may not precede each attack (headache, drowsiness, change of disposition, palpitation, perverted appetite, sexual or other, etc.). Many attacks begin precipitately with absolutely no previous warning. In such cases the patient may or may not utter a piercing sound (*epileptic cry*) falling at the same time, no matter where or in what position he may be. Hence the danger to which epileptics are always subjected. A peculiar onset occurs in the so-called *procursive epilepsy*, in which the patient suddenly starts off and runs some distance before the paroxysm begins.

Paroxysmal Period.—In many cases, whether preceded by an aura or not, this stage is ushered in by a *spasm* that is tonic in character. The patient falls, perhaps because of the loss of consciousness, though in those cases in which he drops precipitately he is probably thrown by the violence of the spasm. The head is usually extended, the muscles of the larynx and trunk contracted, and hence the epileptic cry and the dyspnea, while the lower limbs are generally extended, the upper semiflexed, and the fingers tightly clinched. This period of rigidity lasts but a few seconds before *clonic convulsions* appear.

Intercurrent contractions vary in different cases from very mild movements to those so severe as to toss the individual about. The face, pale at first, becomes congested, and the jaw works in churning the saliva into a froth; this is blood-tinged when the tongue is bitten. The respiration is jerky, gasping.

and there may be a loss of control of the bladder and bowels. In idiopathic cases this stage lasts from one to five or six minutes. The spasms gradually diminish, and without regaining consciousness the patient passes into a deep sleep, immediately preceded in some cases, however, by coma in which the breathing is stertorous. During the sleep, which lasts about an hour, the patient is completely relaxed. On waking he usually appears confused and complains of feeling tired. His limbs may ache for several days.

Occasionally attacks follow one another in quick succession, with no period of consciousness intervening (*status epilepticus*)—a very dangerous condition.

Postepileptic phenomena are variable. The patient may become maniacal, homicidal, or may simply be mentally deficient for a few days, with perhaps some slight speech disturbance. A condition known as epileptic automatism may follow or take the place of the convulsion. In this state the patient may go about, converse, and perform apparently purposive acts of which he has no recollection afterward. In the course of time every epileptic's brain power deteriorates. Paralysis sometimes occurs, is usually transient, and may be unilateral or bilateral.

Nocturnal Epilepsy.—In this condition the attacks occur at night, and may be entirely unknown either to the patient or his friends. He complains from time to time of feeling tired on rising in the morning, his limbs and head ache, and he is generally duller than usual; he may even be confused. Such a history is suggestive, and the suspicion is strengthened if in addition he has urinated involuntarily or if blood-spots are found on his pillow.

Jacksonian epilepsy is characterized by spasm that is generally local in character. It is not true epilepsy (p. 1018).

Myoclonus epilepsy is characterized by epileptic seizures of the ordinary type, while in the interval between the attacks the patient suffers from clonic spasms of various muscles. The spasms vary in intensity from fibrillary tremors (*myokymia*) to violent spasms of the large muscles (*myoclonus*, p. 1165). It may be a family disease.

The so-called *uncinate fits*, which consist of hallucinations of taste, chewing movements, etc., have been described on p. 1020.

Diagnosis.—When a definite history is obtainable the difficulty of the diagnosis is less, particularly if an aura occurs. The attack can be frequently diagnosed from other epileptoid conditions at the time by the explosive onset, the brief tonic and somewhat longer clonic spasm, profound unconsciousness followed by a deep sleep, and when these are present by an involuntary passage of urine, frothing at the mouth, and biting of the tongue.

Differential Diagnosis.—In *uremia* the state of the urine (catheterize if necessary), and often the odor, serve to differentiate it. Hysteria may also resemble it very closely. Gowers has tabulated the chief differences as follows:

EPILEPSY		HYSTEROID	
<i>Apparent cause</i>	None.	Emotion.	
<i>Warning</i>	Any, but especially unilateral or epigastric aura.	Palpitation, malaise, choking, bilateral foot-aura.	
<i>Onset</i>	Always sudden.	Often gradual.	
<i>Scream</i>	At onset.	During course.	
<i>Convulsion</i>	Rigidity followed by "jerk- ing"; rarely rigidity alone.	Rigidity or "struggling," throwing about of limbs or head, arching of back.	
<i>Pupils</i>	Dilated and immobile.	Mobile and active.	
<i>Biting</i>	Tongue.	Lips, hands, or other people or things. Very rare.	
<i>Micturition</i>	Frequent.	Never.	

	EPILEPSY	HYSTEROID
<i>Defecation</i>	Occasional.	Never.
<i>Talking</i>	Never.	Frequent.
<i>Duration</i>	A few minutes.	More than ten minutes, often much longer.
<i>Restraint necessary</i>	To prevent accident.	To control violence.
<i>Termination</i>	Spontaneous.	Spontaneous or induced (water, etc.).

Epileptiform seizures may occur in the course of multiple sclerosis, paresis, and dementia præcox. Organic and toxic causes (p. 1157) must be eliminated before deciding that the condition is idiopathic. For this purpose a careful study of all the organs should be made. If intestinal stasis is suspected, study of the abdomen by *x*-rays is important.

Prognosis.—Idiopathic epilepsy very rarely is cured. In most cases it will be found that an apparent recovery is merely a prolonged intermission. Cases that are evidently symptomatic are sometimes curable if the cause can be removed. Death is seldom due directly to an attack. Fatal accidents may, however, be caused by an attack.

Treatment.—When an aura occurs, advantage may indirectly be taken of it to aid in aborting the attack. The only efficient remedy is nitrite of amyl inhaled as in angina pectoris. In jacksonian epilepsy, constriction of the limb in which the aura occurs may sometimes be sufficient. Every effort should be made to lessen the liability of danger to the patient—first from falling, and second, from the violence of the spasms. One may at times be justified in using ether or chloroform by inhalation to control the severity of the convulsions. After loosening the clothing, and putting a cork or something between the teeth to prevent biting the tongue, nothing more can be done at the time. Between the attacks special care should be taken to put the system in good condition, and all sources of worry and irritation should be removed so far as possible. Particular attention should be given to the stomach and bowels and the removal of all sources of reflex irritations, as eye-strain, adenoids, intranasal obstructions, bad teeth, adherent prepuce, etc. The food should be light and easily digestible, and systematic colonic flushing is often advantageous.

As to *medicinal measures*, the bromids are of the greatest value. The sodium and potassium salts are most commonly employed, the former, as a rule, being better borne by the stomach. They may be given in milk or in one of the medicated waters. Strontium bromid has been used rather extensively of late, and has yielded excellent results. While idiosyncrasies are met with, it may generally be given in from 10- to 20-grain doses (0.972–1.944) three or four times a day, and preferably after meals. Each case must be treated according to its special indications. Symptoms of bromism (acne, sore throat, drowsiness, and gastric disturbance) should be carefully guarded against. Should they develop, the dose of bromid must be reduced, and Fowler's solution administered for a few days. It is well that the latter should be given continuously with the bromids, thereby preventing or, at all events, lessening the liability to bromism. Luminal in doses of a grain or more once daily is often of great service. Other remedies sometimes employed are nitroglycerin, solanum or horse-nettle, atropin, antipyrin, and chloretone. If pituitary insufficiency is suspected, extracts of the gland should be given. Pancreatin has given good results in some cases. Surgical measures occasionally yield good results, this being particularly true in focal epilepsy—*i. e.*, when the cortical centers are the seat of an irritating lesion, as a tumor or depressed fracture which can be removed. Even in these cases, if the convulsions have continued for two years or over, the outlook is not good. It is a curious fact that almost any

surgical operation will diminish or check the epileptic attacks for a time, and I have known as simple a procedure as venesection to afford complete relief in a severe case for several months. The results ascribed to various operations may be explained in large part by this fact. When epileptiform convulsions are due to any of the causes mentioned on p. 1158, treatment should be directed to the cause.

MIGRAINE

(*Hemicrania; Sick Headache*)

Definition.—A neurosis characterized by severe attacks of headache, often paroxysmal and more or less periodic, with disturbances of vision and with or without nausea and vomiting.

Etiology.—The condition is frequently hereditary, and in the large majority of the cases that I have seen it has been transmitted by or through the mother. It usually appears early in life. Various other neuroses are common in families subject to this condition. Females are more frequently affected than males, and migraine seems to be associated with diseases peculiar to women, especially menstrual disorders. Among the exciting causes may be mentioned gastric disturbances, dental irritation, nasopharyngeal diseases (adenoids, etc.), eye-strain, grief, emotion—in short, anything that tends to lower the physical or mental tone occurring in those hereditarily predisposed. Recently attention has been called to auto-intoxication (leukomainic poisoning) as a cause of certain cases. A gouty diathesis seems to be operative in many cases.

Pathology.—This is profoundly obscure, since no lesion has ever been discovered. It is probably an auto-intoxication associated with vasomotor disturbance, and the transient paralytic symptoms that may occur are believed to be due to arterial spasm. Very rarely the disease has been observed in some subjects to replace an attack of epilepsy or even to alternate with true epileptic attacks.

Symptoms.—As a rule, the patient can prognosticate an attack. In the cases of slow onset he may feel indisposed for some hours before, being languid, drowsy, with general discomfort and perhaps nausea. In other cases various *subjective sensations* occur, lasting from a few minutes to several hours. Of these, disturbances of vision are most common, such as flashes of light, spectra, visions of animals or weird forms, or scotoma, etc. Lateral homonymous hemianopsia has also been observed. Auditory sensations are rare, as are those of the other special senses. Transient palsies and aphasia also may appear, the latter occurring when the pain is on the right side. The palsies are often hemiplegic, being present on the side opposite to that in which the pain is. Numbness and tingling may also be symptoms. Complete oculomotor palsy, lasting several days, may occur. After these phenomena have existed for some time *headache* supervenes, when, as a rule, they cease. The pain, at least in the beginning, is usually unilateral, as the name suggests, though later it may and often does involve the entire cranium, spreading from a single point of origin—over one eye, for instance. The affected region may be tender to the touch or it may be the seat of numbness or tingling. *Nausea* and *vomiting* are common symptoms, with or without vertigo. Vasomotor symptoms are frequent, usually the face is pale (angiospastic type), but it may be flushed (angioparalytic type). A brief period of unconsciousness occurs in some cases, and spasmodic movements may also be observed occasionally. This fact is of particular interest, since it serves to support the view that migraine is in some way related to epilepsy, and, as has been stated, attacks of migraine

and epilepsy may alternate. Unlike epilepsy, migraine does not tend to impair the mental faculties, no matter how long the patient has been afflicted. During an attack, however, he may have melancholia or be incapacitated mentally and physically for two or three days.

Course.—The disease generally begins in early life, and in nearly half of the cases before the fifteenth year, recurring with a certain degree of periodicity until old age, when it often passes away. It may cease in women at the menopause, and in men between the fortieth and fiftieth years.

The **prognosis** is good as far as life is concerned. This disease is incurable, though the condition of the patient may be alleviated.

Treatment.—The management of the disease may be considered under two heads: (1) treatment of the attack, and (2) the treatment between the attacks, which necessarily includes prevention. The patient should be put to bed in a slightly darkened room, and all sources of noise and confusion should be removed as far as possible. The attack may be so severe as to justify the use of morphin hypodermically. The coal-tar derivatives have met with most favor, however, as remedial measures, and preferably antipyrin and phenacetin, though their occasional depressing effect should be borne in mind. Caffein may be given with phenacetin with advantage, and aromatic spirits of ammonia is a useful adjuvant to antipyrin.

Acetanilid may often be substituted for phenacetin with apparent advantage. In twenty-four hours this may be discontinued, and potassium bromid should be given in liq. ammon. acetatis in doses of gr. x to xv (0.648–0.972). Local applications of menthol, or fly-blisters may be employed, or even superficial points may be made with the actual cautery. The rapidly interrupted faradic current applied with a dry wire brush over the painful side of the head may give temporary relief. Washing out the lower bowel has been recommended.

In the angiospastic type full doses of nitroglycerin may be of service.

Between the attacks the general health should be carefully looked after. The so-called uric-acid diathesis is common in subjects of migraine. Haig staunchly advocates the use of salicylates in such cases in addition to the dietetic measures. Anemia should be treated by iron in some form, dialyzed or Blaud's pill. The bowels should be kept normal by means of some saline (Hunyadi, etc.), or by the fluidextract of cascara sagrada. An examination of the stomach contents often shows the existence of anacidity; when this is corrected there is usually marked improvement in the migraine. The extract of cannabis indica is employed by some over a long period of time, just as the bromids are in epilepsy. It is given in doses of gr. $\frac{1}{4}$ to $\frac{1}{2}$ (0.0162–0.0324), two or three times a day, after meals. While exercise and fresh air are admirable adjuvants to any form of treatment, it must not be forgotten that fatigue invites an attack. Proper rest, care and regularity in dieting, and the avoidance of excitement are the chief points to be observed.

ACUTE CHOREA

(*Sydenham's Chorea; St. Vitus' or St. Anthony's Dance*)

Definition.—The type of chorea described by Sydenham is a more or less acute disease, due to an infectious agent or its toxin. It has a special predilection for children, and is characterized by involuntary, irregular, non-purposive muscular movements, more or less marked mental change, by a great liability to endocarditis and a tendency to recurrence, particularly during the spring and fall. It has a close relation to acute articular rheumatism.

Pathology.—No definite lesion can be ascribed to the disease. The disease is, however, probably due to the action of a bacterial poison upon the brain cortex, which causes more or less cortical hyperemia, small hemorrhages and areas of softening, and infiltration of the perivascular spaces with round cells. In some cases at least the infection is due to the *Micrococcus viridans*. In about 25 per cent. of the cases there is an association of chorea and acute articular rheumatism.

Etiology.—(1) *Age.*—By far the greatest number of cases occur before the twentieth year, but it may develop at any age. Most cases occur between the tenth and fifteenth years.

Sex.—Females are most frequently attacked, and probably in two-thirds of all cases.

Race.—Acute chorea is rarely met with except among the white races.

Heredity.—A history of other neuroses (hysteria, epilepsy, etc.) in the ancestors may be obtained, and an unstable nervous system obtained from such stock may predispose to the disease. Children who develop chorea are especially apt to be of a nervous, excitable temperament, and may be hysteric as well as choreic. It is in cases of this type particularly that *fright* acts as an exciting cause.

Infectious Diseases.—There seems to be a relationship between some cases of chorea and other infectious diseases. This, however, is only at all marked in acute articular rheumatism and scarlatina. It is not yet proved, however, as has been claimed, that chorea and rheumatism are due to the same cause. The possibility of the infection entering through the tonsils must be considered, and these structures are frequently found enlarged and diseased.

Pregnancy is a frequent cause of chorea in adult life. When so caused, it is apt to be severe. It is most prone to develop during the earlier months, and especially in primiparæ. It often assumes the maniacal type.

The influence of *reflex irritation* is probably much overrated, whether intestinal, genital, or from ocular defects, but these may aggravate the disease.

Symptoms.—The common or ordinary form is frequently met with, especially during the spring and fall. Primary attacks may occur at any time, but recurrent outbreaks are most prone to develop in the spring. There is a slight affection manifested by restlessness, disturbed rest at night, and by irregular and purposeless *muscular movements*, that are most marked in, or entirely confined to, the upper extremities, the head, or the facial muscles; or the condition may be unilateral. They usually cease during sleep. *Endocarditis* may not give rise to characteristic signs. More or less *muscular weakness* is present and the patient tires very readily. The child's *disposition* is changed, outbursts of temper being quite common on the slightest provocation. *Fever* is absent in this form unless complications exist, though when severe joint troubles or endocarditis are present, the temperature will rise. *Anemia* is often present, and with it headaches, irritable heart, and hemic murmurs. Indeed, in some instances not even a murmur can be heard, though *postmortem* records of cases with a history of chorea show that in most of them the valves are affected. The mitral valve is most commonly involved, the endocarditis usually being of the verrucose type. There are rarely any sensory symptoms, severe pain, at all events, being extremely rare. Little dependence can be placed on complaints of tingling or burning pain unless they are voluntary, for the mental make-up of choreic patients is such that they are apt to dwell upon slight ailments suggested to them through leading questions. The reflexes do not differ from those of normal children.

There is a more severe type of chorea, in which the movements are extremely violent, causing severe injuries, even fractures, and leading in some cases to

HUNTINGDON'S CHOREA

(Chronic Progressive Chorea; Hereditary Chorea)

Definition.—An hereditary disease affecting many members of a family, developing in early adult life, and characterized by irregular muscular contractions, inco-ordination, and progressive dementia. The disease was first definitely described by Huntingdon in 1872, but other writers had already alluded to it. Sporadic cases are reported from time to time.

Etiology.—The disease is strictly hereditary, and has been traced through five generations. The offspring of parents that escape are forever immune. It occasionally alternates with idiocy, epilepsy, and various degenerative conditions. The possibility of degeneration of the lenticular nuclei as a cause should be considered.

Pathology.—The changes found consist of chronic pachy- and leptomeningitis, chronic hemorrhagic encephalitis, characterized by round-cell infiltration of the cortex, degeneration of the ganglion-cells, proliferation of the neuroglia, sclerosis of the blood-vessels with dilatation of the perivascular and lymph-spaces, and numerous hemorrhagic foci (Facklam). There are also atrophy and thinning of the cortex, slight irregular changes in the spinal cord, and multiplication of the nuclei in the muscles.

Symptomatology.—The *choreiform movements* commence insidiously and only in the rarest cases become pronounced. They are usually susceptible to voluntary inhibition and disappear during sleep. They usually appear first in one extremity and then gradually invade the other parts of the body. There is considerable *inco-ordination* of movement. Speech is frequently indistinct. The *mental symptoms* consist of progressive dementia, irritability often attaining maniacal violence, delusions of persecution, and rapid diminution of intelligence. In some cases the mental changes are very slight.

The **course** is steadily progressive, but the patient may live to an advanced age.

Diagnosis.—The only condition likely to cause confusion is senile chorea with dementia. In this the mental symptoms are usually slight and the motor symptoms more violent. The family character of the disease is also lacking. By many, however, this is supposed to be a type of Huntingdon's chorea.

Treatment is entirely symptomatic.

PARAMYOCLONUS MULTIPLEX

(Myoclonus Multiplex)

Definition.—This is a disease of unknown pathology, first described by Friedreich, and, as its name implies, characterized by clonic contractions in various groups of muscles.

Its **etiology** is obscure. Heredity unquestionably plays an important part, nearly all the patients having among their ancestry cases of one or more forms of nervous disease. Emotional disturbance, as fright, is often the exciting cause. It usually develops in early adult life, and is probably more common in males. In one case that I observed it was associated with idiocy.

The **symptoms** of the disease consist of *clonic contractions* of individual muscles, which cause either no or very little movement of the parts controlled by them, occurring chiefly in the muscles of the extremities and the trunk, and only occasionally involving the muscles of the face. These contractions

The *prognosis* is extremely unfavorable, death occurring in 90 per cent. of the cases. The duration of the disease varies from two or three days to four or five months, death usually occurring from heart failure while the patient is comatose.

No satisfactory *treatment* has been suggested.

DYSBASIA LORDOTICA PROGRESSIVA

This affection, also termed *dystonia musculorum deformans* and *tortipelvis*, has been described by Oppenheim.¹ It occurs in children and young adults of the Jewish race. The symptoms consist of tonic and clonic spasms of the muscles around the pelvis, associated sometimes with similar twitchings of other muscles. These cause a deformity around the pelvis. Excepting the deformity the symptoms disappear when the patient is recumbent. Attempts either to stand or walk develop them. There is marked lordosis in the lower dorsal and upper lumbar regions, with prominence of the buttocks and a peculiar gait which has been termed "the monkey or dromedary gait." The muscles are often hypotonic, and tremor, choreiform and athetoid movements may be associated. Late investigations seem to show that disease of the corpus striatum may be responsible for it² (pp. 1021 and 1143).

TIC

(*Habit Chorea; Habit Spasm; Tic Convulsif; Motor Tic; Palmus*)

Definition.—Meige³ has defined a tic to be "a co-ordinated purposive act, provoked in the first instance by some external cause or by an idea; repetition leads to its becoming habitual, and, finally, to its involuntary production without cause and for no purpose, at the same time as its form, intensity, and frequency are exaggerated; it thus assumes the characters of a convulsive movement, inopportune and excessive; its execution is often preceded by an irresistible impulse, its suppression associated with discomfort. The effect of distraction or of volitional effort is to diminish its activity; in sleep it disappears. It occurs in predisposed individuals, who usually show other indications of mental instability."

Etiology and Symptoms.—These have been practically described in the definition given above. A few points should be emphasized. The disease is especially apt to develop in those who possess a neuropathic ancestry, and who themselves show other evidences of a neurotic diathesis, as neurasthenia, hysteria, etc. Most cases are originally excited by an effort to relieve some peripheral irritation. Thus, a man who had a sore spot on the upper lip which he was constantly moistening with his tongue found that after the sore had healed he continued to protrude the tongue involuntarily. This protrusion has occurred more or less frequently since, until it has become an unconscious act, and at the same time the tongue is protruded much further than would occur in a normal protrusion. By concentrating his attention upon himself he could prevent this, but a marked feeling of discomfort was caused by so doing. He had had several attacks of "nervous breakdown."

¹ Fraenkel, *Jour. Nerv. and Ment. Dis.*, June, 1912, p. 361.

² Hunt, *Jour. Amer. Med. Assoc.*, November, 11, 1916, p. 1430.

³ "Tics and their Treatment," Meige and Feindel, translated by Wilson, p. 260.

Tics may develop at any age. Any group of muscles may be involved. Thus, we have facial or mimic tics, tics of the nose or sniffing tics, of the lips or sucking tics, of the jaws or biting tics, of the tongue or licking tics, of the neck or nodding tics, of the trunk muscles, of the arms, of the hands, or scratching tics, of the legs or leaping tics, of respiration or snoring, sniffing, blowing, whistling, coughing, and sobbing tics, etc. Any voluntary and purposive act may be so simulated. The movements are usually quick, and, as has been said, are imitations and exaggerations of normal acts. The predisposed may acquire the condition by imitation of one who has the disease.

Diagnosis.—In the first place, this must be made from a true spasm. A spasm, as defined by Meige (*loc. cit*), is the motor reaction consequent on stimulation of some point in a reflex spinal or bulbospinal arc. In other words, it is due to some irritative lesion. Patrick has well summarized the points of difference, part of which are here given: Tic is more common than spasm, and invariably develops in a nervous or neuropathic individual. Disposition or temperament appears to have nothing to do with spasm.

Spasm is absolutely devoid of voluntary or involuntary control, while tic, to some extent, is always under the control of the will, and always subject to involuntary control by strong emotional or intellectual pre-occupation. Spasm is an anatomic, tic a physiologic, disorder. Voluntary simulation of a true spasm is practically impossible. The patient himself can always repeat or imitate his tic movement, and another person can nearly always do so. A spasm in its incipency may be confined to part of a muscle or of the muscles taking part in a movement (fascicular contractions). A tic always involves all of the muscles taking part in any one physiologic movement. From chorea tic is readily distinguished by the co-ordinate and purposive character of the movements; from tic douloureux (p. 1039), by the absence of pain. In the so-called general tic, or Tourette's disease, there are mental symptoms (*infra*) which do not occur in the form just described.

Prognosis and Treatment.—The prognosis is doubtful as regards cure. Of course, it does not cause death. The treatment is educational—that is, training the patient to perform movements the opposite to those involved in the tic; this he can do before a mirror several times daily. In addition, measures to improve the neuropathic state—viz., fresh air, easily digested, plain food, etc.

GENERAL TIC

(*Maladie des Tics convulsif; Maladie de Gilles de la Tourette*)

Definition.—A disease apparently psychic in nature and characterized by co-ordinated spasmodic movements, explosive sounds or words, and imperative ideas, without intellectual disturbance.

The **pathology** of the disease is unknown. It occurs in those suffering from neuropathic heredity, and usually indirectly. It most frequently commences in childhood—that is, before puberty—and affects either sex.

Symptoms.—The disease generally commences in the *orbicularis palpebrarum*, the first movement being an uncontrollable winking. This, as a rule, is rapidly associated with movements of the muscles of the face, causing the patient to exhibit various *grimaces*; finally, other muscles of the body may be involved, and the patient is compelled to repeat many times some apparently purposeful and co-ordinated movement, as the brushing away of insects or the stroking of the beard. From time to time he emits sounds that may be either inarticulate cries or imitation of some animal, as the crowing of the cock or the barking of the dog, or the repetition of some obscene word (*coprolalia*). These

movements are partially under control of the will, and are diminished by occupation, but increased by emotion. At other times the patient is compelled to imitate sounds that he has just heard, no matter how unusual or unexpected (*echolalia*). A more curious symptom is the imitation of movements that he has observed (*echokinesis*), which may lead to most absurd or painful results. Still another psychic symptom is the occasional development of imperative ideas. These usually take the form of a desire to recall some unimportant word or syllable (*onomatomania*) or the performance of difficult problems in mental arithmetic (*arithmomania*). One of my patients, a boy of fourteen years, before undertaking a definite act, would repeat the words "ten, ten, ten," three times, followed by a rapid count of figures from one to ten. If riding in a public conveyance, he would do the same, endeavoring to finish before reaching a definite place, as a street corner, or before hearing the sound of the voice or whistle of the conductor if in a trolley car. A failure to accomplish the task was cause for intense mental worry. These patients are usually affected at the same time with a certain degree of melancholia or anxiety that interferes to some extent with their normal life. The disease is, as a rule, very obstinate, and ordinarily continues throughout life.

The **differential diagnosis** is not difficult, the presence of motor tic, associated with the peculiar mental symptoms, being characteristic.

The **prognosis** is unfavorable for cure; death, however, almost never occurs as the result of the disease.

The **treatment** is symptomatic, and consists in putting the patient in the most favorable physical condition possible; also hydrotherapy, change of climate, tonics, and the correction of any atonic condition, are all useful measures. Potassium bromid to a certain extent controls the paroxysms when they become very severe.

SALTATORIC SPASM

(*Jumpers; Latah*)

Definition.—This is a term applied to a peculiar clonic contraction occurring in the lower legs of a patient on attempting to stand upright. The disease was first described by Bamberger. It appears to occur more frequently in men than in women, and usually in individuals who have suffered from other functional diseases. Occasionally it appears in those who exhibit hysteric phenomena. The condition may develop after severe exertion, and sometimes appears during convalescence from an acute disease. In one of my own cases the condition suddenly arose in the course of habit chorea. Saltatoric spasm is not a clinical variety of true chorea.

Symptoms.—This condition is probably related to the tics (p. 1167). When the patient attempts to stand, violent clonic convulsions take place in the muscles of the legs, particularly of the calves. These may cause the patient simply to rise on his toes, or they may be so severe as to cause him to spring from the ground, in which case he usually falls. As soon as he lies down the spasms disappear, but they may be produced in patients lying in bed by pressing against the feet.

The **prognosis** is generally favorable. The attacks usually last for a period of from two days (Gowers) to a few weeks, but a few cases have been recorded that persisted throughout life. Gowers recommends diaphoretic treatment. Antispasmodics may also be employed, and in those cases with hysteric stigmata suggestion is useful.

The pulse is usually rapid; the skin flushes easily, and the patients are sensitive to cold. There are no trophic or sensory symptoms, and the reflexes are normal. Apart from the diffidence, amounting in some cases to a positive dislike for meeting people, and the melancholia occasionally induced by brooding over the affliction, there are no mental changes.

Cases occur in which the tremor is very slight or absent, the diagnosis then being based on the rigidity, attitude, and facial expression.

Course.—The disease is almost always of slow onset and of insidious progress. Often one side is involved before the other, or the two sides are unequally affected. Very rarely the earlier symptoms may develop somewhat rapidly, but in every case their further progress is slow. Disappearance of tremor, usually transient, has been observed in the side affected by a subsequent hemiplegia. The course may be interrupted from time to time; even seeming improvement may take place, but it is not maintained. The disease lasts for years, and the patient usually dies of some intercurrent disease.

The **diagnosis** is not at all difficult when the tremor, attitude, gait, and rigidity have developed. During the earlier stages it may be confounded with *multiple sclerosis*, though this condition develops earlier in life, and the volitional character of the tremor, the nystagmus, and the scanning speech should serve to differentiate it. The muscular rigidity, peculiar gait, and temporary cessation of the tremor after some muscular effort distinguishes it from senile tremor. That the rigidity is not due to disease of the central motor neuron is shown by the absence of the Babinski reflex, and, in most cases, absence of increased tendon reflexes.

Treatment.—The medical management of the disease is unsatisfactory. Graduated exercise, tepid baths, and massage should be employed to keep up the tone of the muscles. The patient should avoid excitement and over-fatigue, both mental and physical. The long-continued use of arsenic may be of service, and hyoscin hydrobromate (gr. $\frac{1}{100}$ – $\frac{1}{100}$ t. i. d.) often relieves the symptoms. Parathyroid gland (gr. $\frac{1}{10}$ of the powdered gland) three or four times daily has been recommended.

OTHER FORMS OF TREMOR

1. **Hereditary tremor** has been described by C. L. Dana, who has also reported interesting cases. It may commence in infancy and continue until old age, unaccompanied by detectable lesions.

2. **Simple tremor**, lasting a longer or shorter period (oftener it is comparatively brief), is a rare condition and without serious possibilities. Its etiology is unknown, though it is sometimes aggravated by nervous shocks and other debilitating conditions.

3. **Senile Tremor.**—This is common in old persons, and rarely appears before three-score-and-ten years. It is excited by muscular motions, is always fine, and affects chiefly the hands and arms; more rarely the neck is also involved, and the head may then be seen to tremble.

4. **Toxic Tremor.**—This results from the action of alcohol, lead, mercury, tobacco, and other poisonous substances. It is usually fine and irregular (*vide* The Intoxications).

5. **Hysteric tremor** (*vide* Hysteria).

6. Tremor may also be a symptom of neurasthenia, exophthalmic goiter, paresis, and multiple sclerosis.

TETANY

Definition.—A disease of unknown cause, characterized by paroxysms of tonic cramp that usually affect the flexor muscles of the extremities, by sensory disturbances, and by a peculiar alteration of the electric reaction of the muscles.

Etiology.—Tetany may occur in epidemics, and has, therefore, been supposed to be infectious. There is some doubt, however, whether these epidemics are cases of true tetany or are hysteric in nature. There is also some evidence that it is due to an intoxication occurring in the course of some other morbid condition. Tetany is frequently associated with infectious diseases; it also occurs in connection with gastro-intestinal disorders, especially dilatation of the stomach, diarrhea, and intestinal parasites, during pregnancy and lactation, and it is associated with the myxedema that develops after the removal of the thyroid gland, in which cases it is due to the parathyroids also being removed. Exposure to cold has often preceded the disease. Occupation seems to exert a remarkable influence upon the predisposition to it, the great majority of those affected being shoemakers or tailors. In childhood males are far more frequently attacked than females, and the victims are frequently rachitic, but in adult life this proportion is reversed. Heredity may have some influence, since tetany often occurs in several members of the same family. It is much more common in the spring months, and, curiously enough, it appears to be endemic in certain localities, particularly Leipsic and Vienna. It is rare in the United States.

Pathology.—Distinct morbid lesions of the nervous system have not been found in all cases. Slight vascular changes in the brain and cord and vacuolization of the ganglion cells have been described, but these are not peculiar to this disease. It has been supposed that changes ought to be found in the motor nerves, but the most careful observers have failed to detect them. It is evidently occasioned by a toxemia which, in some cases, is due to absence of disease of the parathyroid glands. Excessive excretion of calcium salts is found in the urine.

The **symptoms** fall naturally into two groups: (1) Those of the paroxysm and (2) those of the interval. (1) The **first symptoms** of an attack usually consist of peculiar sensory disturbances in the limbs, either tingling, formication, pain, or numbness, and these may precede the attack for some hours or even days. Stiffness of the muscles usually begins in the fingers. There may be slight clonic movements at first, but this is not frequent. The limbs are symmetrically involved. The *spasm* commences first in the hand, the fingers being straightened and flexed upon the hand, and bunched so that the hand has been likened to that of the scrivener or obstetrician. The spasm then extends to the muscles of the forearm and arm, and usually also to the feet and lower limbs. If the cramp is slight, the pain may be insignificant, but ordinarily it is severe, and is increased by attempts to overcome the contractures. The muscles are hard, painful upon pressure, and occasionally fibrillary twitching may be observed. There is sometimes a slight edema, and often sweating of the limbs. The paroxysms may last for several minutes or for several hours or even days, and may even persist during sleep. If, however, the period is very long, remissions are usually observed. Sometimes a series of paroxysms may occur with considerable regularity. Attacks are more likely to occur at night, and they may also be brought on by prolonged and severe muscular effort, or by emotional shocks. Besides the paresthesiæ in the affected extremities, the patient may suffer from severe headache or pain in the back and neck.

(2) The **symptoms of the interval** are—*Trousseau's sign*—i. e., the possibility of causing an attack by prolonged pressure upon the main nerve-trunks or vessels of the limbs. Frankl-Hochwart has shown that pressure upon the nerves is essential; pressure upon the vessels acting secondarily if at all. *Chvostek's sign* is a peculiar excitability of the muscles of the face, so that spasms are produced if the trunks of the facial nerve are lightly percussed by a hammer. This occurs in other conditions, particularly the cachexiæ, but in most cases of tetany the spasm occurs if the skin of the face is lightly stroked; and this reaction appears to be pathognomonic. *Erb's sign* consists of a greatly increased electric excitability of the muscles, and, occasionally, of an alteration of the electric reaction, so that ACIC may be greater than KCIC. Moreover, AOTe is often obtained, and, in at least 2 cases, KOTe has also been noted. The last two reactions occur in no other condition. *Hoffman's sign* consists of an increased reaction of the sensory nerves to electric stimuli. The facies of the patient is peculiar and characteristic. The face is slightly swollen, dusky, and expressionless, but if carefully examined usually no edema can be detected. Often this swelling is also found in the hands and feet, and may be associated with distinct enlargement of the veins. Even during the interval the feet when at rest have a tendency, particularly in children, to assume a slightly inverted and extended position.

The *sensory disturbances* consist of cramp-like pains during the attack, some diminution of sensation in the affected parts, and increased sensibility of the sensory nerves. The contractures are not invariably limited to the extremities. Sometimes the muscles of the neck, back, and larynx are involved; sometimes also the diaphragm, and occasionally the compressor urethræ. Involvement of the larynx gives rise to stridulous respiration; involvement of the diaphragm to severe dyspnea; when the urethra is compressed there is retention of the urine. *Fever* occurs in about one-half the cases; it is slight and generally limited to the paroxysm. The urine usually contains a large amount of phosphates, and less frequently indican is present in excess. Partial tetany—that is, with the absence of one or more of the cardinal signs—occurs not infrequently, especially in gastro-intestinal conditions. Pain, cramp, and Trousseau's sign are usually present.

The **differential diagnosis** is very easy, as a rule, if the patient is seen during a paroxysm. The severer forms may, however, be confounded with *tetanus* or *meningitis*. Tetany can be distinguished from the former by the fact that the spasm begins at the periphery and rarely affects the muscles of the jaw. From the latter it may be diagnosed by the absence of coma and the slighter degree of fever. The diagnosis from certain forms of *ergotism* is more difficult, and can often be made only by careful attention to the etiology. The *hysteric forms* can be differentiated by finding various hysteric stigmata. An epidemic occurring among young women should give rise to a suspicion of the true nature of the malady.

Prognosis.—The duration varies from a few days to many months, the most obstinate forms being those due to thyroidectomy, in which the parathyroids have also been removed, and chronic diarrhea. The disease cannot be said to have disappeared until the characteristic symptoms of the interval (Trousseau's, Erb's and Chvostek's signs) can no longer be elicited. The prognosis is usually favorable, nearly all cases tending to spontaneous cure. Death, however, may occur from chronic diarrhea, from respiratory failure when the diaphragm is involved, and from cachexia strumipriva.

The **treatment** is purely symptomatic. The patient should be placed in the most favorable hygienic conditions and given plenty of nourishing food, especially that containing calcium salts. Full doses of these salts, as calcium

chlorid, or lactophosphate, or iodid, should also be given. During the spasm bromids or chloroform inhalations seem to give the best results. The most important therapeutic measure is the correction of the underlying cause. Thus, in children, rachitis is almost invariably associated with tetany, and the most efficient remedies are iron and cod-liver oil. Intestinal disorders should be treated according to the principles laid down in the discussion of these diseases. The form due to removal of the thyroid gland usually disappears under a course of parathyroid medication, while that occurring during pregnancy usually persists until delivery.

PERIODIC PARALYSIS

(*Family Periodic Paralysis*)

Definition.—A disease characterized by paroxysmal attacks of complete paralysis, and alteration in the electric reactions, occurring in many members of a family.

Pathology.—In excised fragments of muscle Goldflam and Oppenheim found hypertrophy of the fibers and slight vacuolation, without multiplication of the nuclei or proliferation of the connective tissue. In most cases no changes have been found, and the condition has been supposed to be an auto-intoxication, associated with a lowered condition of metabolism. In a case observed by Mailhouse there was a diminished excretion of calcium and magnesium salts in the urine, and he mentions the possibility of the paralysis being due to their inhibitory influence upon nerve and muscle when retained within the body.

Etiology.—The disease is purely hereditary. Both sexes are affected. The attacks appear to be more frequent in summer, and often seem to occur either after overfilling the stomach or excessive muscular exertion.

Symptoms.—The attacks are preceded by *prodromes* in the form of vague discomfort or paresthesia. The patient then usually falls asleep and awakens completely paralyzed. Speech, deglutition, and the sphincters are unaffected. During the attack there is often transient *albuminuria*, with blood-cells in the urine. The *reflexes* are abolished, and the muscles either do not react well or not at all to the electric current. The *paralysis* lasts from twelve hours to three days, and then there is an outbreak of perspiration, with gradual recovery, the muscles of the head first regaining power. During the interval the muscles react to electricity and the reflexes return. Dilatation of the heart has existed during an attack, to disappear during the interval. A few cases have been associated with migraine.

Prognosis.—The disease does not usually kill; but there appears to be no tendency to recover, and a few cases have died during the attack.

Treatment.—This involves only caring for the children during the attack. Large doses of potassium citrate have been beneficial.

HYSTERIA

Definition.—A state in which ideas control the body and produce morbid changes in its functions (Moebius).

Pathology.—In it there is a constitutional tendency, often congenital, to excessive reaction to emotional stimuli, which may be trivial. This leads to hypersuggestibility, the suggestion being either formed within the mind of the patient or received from without. By such suggestions the symptoms are produced and by them also they may be made to disappear. The symptoms,

it may be said, are due to a dissociation of the personality in which ideas existing in the subconscious, but not recognized, become predominant.

Etiology.—There are a large number of predisposing and exciting factors, all of which, however, may be grouped under a few dominant heads. Thus among the former must be mentioned, pre-eminently, *heredity*. The investigations of many neurologists and alienists of divers lands have gone far to demonstrate that at the foundation of the vast majority, if not of all, of the hysterias is to be discovered an inherited neurotic tendency or temperament. The family histories of these patients generally reveal a large number of consanguineous, neurotic, or hysteric individuals. It is apparently in close relationship with the various psychoses and major neuroses (epilepsy, chorea, tetany), and with the so-called rheumatic diathesis.

In the process of transmission one generation may entirely escape the pernicious influence, and successive generations may manifest strikingly different evidences of the disease, in one the neurotic and in another the psychic element predominating. A curious phenomenon that is worthy of mention is the apparent *contagiousness* of hysteria; moreover, the baleful influence one neurotic individual exerts over the unfortunates of this temperament explains the so-called "hysteric epidemics" that have swept over communities, and even over vast tracts of land or entire countries, at different periods of the world's history. Similar, though limited, outbreaks may still be seen in the nervous wards of hospitals or in religious and political conventions, and these depend largely upon the general prevalence of the neurotic disposition untempered by a virile will-power.

The hysteric temperament may be, and often is, fostered by improper and pernicious modes of life, especially by luxurious and sensuous living and by the habit of gratifying every desire of the will during early life. It is manifested at this early stage of the individual's existence by hypersensitiveness, brilliancy, undue enthusiasm, and a more or less erratic turn of mind.

Contrary to the prevailing opinion, hysteria is not limited to the female sex, although they are the chief sufferers from the more dramatic forms. Instances of a most rebellious nature not infrequently occur in the opposite sex.

Age.—The condition is generally encountered between the ages of fifteen and thirty years, although it is observed in young children. After the latter age the frequency of the disease rapidly diminishes.

Anything which tends to lower the nutrition and nervous stability, as improper hygienic surroundings or the existence of neurasthenia (p. 184), and the influence of certain chronic toxemias, as alcohol, mercury, morphin, and lead, may predispose to it.

The *exciting causes* of hysteria may be grouped as follows:

(1) Most commonly it follows some profound emotion or mental or moral shock. Thus, in neurotic males it may be excited by excessive and protracted business worry or excitement, or by active competition in certain lines of occupation, or by some heavy and unexpected monetary reversal. In females it is not uncommon as a sequel to the establishment of puberty and the menstrual function, or to the physiologic arrest of menstruation at the period of the climacteric. Especially is it prone to develop in young and illegitimately pregnant women, or during the first pregnancy in newly married women of a neurotic temperment. Great religious excitement during the progress of a revival wave and profound political upheavals have been most potent in establishing the disease in numerous instances; and other profound mental impressions, of fear, grief, or great and unexpected joy, have assumed the exciting rôle. In this connection the theories of Breur and Freud, now receiving considerable attention, but only accepted by a comparatively few, should

be mentioned,¹ but in the space at hand it is impossible to give them in detail. They teach that hysteria is always due to a physical or psychic trauma, which may have occurred some time before the symptoms develop. According to Freud, the trauma practically always is sexual in nature. Thus there develop in the period before puberty definite sexual activities, which are mostly of a perverse nature. These activities do not, as a rule, lead to a definite neurosis up to the time of puberty, which, in the psychic sphere, appears earlier than in the physical; but sexual fantasy maintains a perverse direction by reason of the infantile sexual activities. On constitutional (affect) grounds the increased fantasy of the hysteric leads to the formation of complexes which are not taken up by the personality, and, by reason of shame or disgust, remain buried in the subconscious mind. There therefore results a conflict between the characteristic normal libido and the sexual repressions of these buried infantile perversions. These conflicts give rise to the hysteric symptoms.²

(2) Extreme physical prostration, the result of some very acute or much protracted chronic disease, may exert an etiologic effect. Thus, some of the most marked and intractable forms of the disease have resulted from the specific fevers (typhoid, typhus, and the other exanthemata), while it is not rare in a varying degree in the final stages of tuberculosis, chronic nephritis, and other grave constitutional affections of long standing.

(3) The so-called "traumatic hysteria" has come to occupy a prominent place in the etiologic category of the disease. Especially do we find the incurable varieties of hysteria resulting from a slight or, it may be, a more severe traumatism. It must be remembered that a considerable period of time may intervene between the date of the injury and the appearance of the initial hysteric symptoms, so that in all cases it becomes of the utmost importance to make a careful study of the patient's history for signs of traumatism, however remote. It has also been noted that oft-repeated minor traumatism may finally result in some hysteric manifestations. Most of the cases designated during the late war as "shell shock" were hysteria due to either prolonged physical and mental strain, fright, traumatism, or a combination of these causes.

(4) Finally, in a limited number of cases coitus interruptus, sexual excesses, and masturbation are the influential factors in the production of hysteria. These sexual cases, though few in number, do exist, and are especially to be found among the class of so-called sexual perverts.

Clinical History.—Clinically, hysteria presents three well-marked stages, known respectively as the *prodromal*, the *convulsive*, and the *latent*. The latter is also designated as the *interconvulsive stage* or the *period of the stigmata*, and during this period the number of the symptoms and their complexity almost baffle attempts at classification; they can, however, best be portrayed by presenting them under the heads of the various systems (*vide infra*).

(1) **The Prodromal Stage.**—The prodromes are invariably present, and at times they are more marked than at others. They are evident alike to both patient and physician, and are largely psychic in nature. Prominently among these is an abnormal desire for notoriety and sympathy. There may be noted a marked mental depression associated with introspection, and, it may be, with a form of mild mania or of melancholia. A condition of aprosexia develops, and the patient becomes irritable, restless, and discontented. There may also be disturbances of the gastro-intestinal tract—viz., anorexia, nausea, vomiting, constipation, and perversions of taste. These phenomena persist for several days and are followed by emotional disturbances—spasms of hysteric laughing and crying—that immediately precede the *aura*, which is as marked a feature

¹ *Psychoanalysis*, Brill, W. B. Saunders Co.

² Jelliffe, *Osler's Modern Medicine*, vol. vii., p. 816.

in hysteria as in epilepsy. It may assume one of a number of forms, but more commonly it has an ovarian, a cervical, a cerebral, or a surface or cutaneous origin (unilateral). Very frequently the convulsion is preceded by a condition of extreme sensitiveness and pain in one or both ovarian regions, so that the lightest touch at a point on the abdominal surface 1 inch above Poupart's ligament, and midway between the pubis and the anterior superior iliac spine, will elicit exquisite tenderness. This is so constant and characteristic that many patients can invariably predict the onset of the convulsion. Not infrequently the aura begins in the neck, the patient experiencing a sensation as of a ball lodging in the throat (*globus hystericus*): this is due to a spasmodic contraction of the muscles of the pharynx and esophagus, and is accompanied by tachycardia and a sense of suffocation. If the aura originate above the scalp, it is characterized by the sudden appearance, generally in the top of the head, of a severe neuralgic pain, as if produced by the entrance of a nail (*clavus hystericus*); this is frequently associated with vertigo and tinnitus aurium. The aura, finally, may appear in the form of spots of cutaneous tenderness, mainly localized upon the trunk, to which areas has been given the name of *hysterogenous zones*.

(2) **The Hysteric Convulsion.**—Closely following upon the footsteps of these prodromes, and immediately following the aura, the hysteric convulsion may appear. Most commonly this is epileptoid in nature; rarely it assumes a less common type. Hence it becomes necessary to describe several of the forms of the convulsions—viz.: (a) the *epileptoid* (hystero-epilepsy); (b) the *gymnastic* (clownism); (c) the *emotional cataleptic*, or *dramatic*; and (d) the *delirious*. All of these forms may be present in the same attack, the one passing quickly into the other, or, as in the abortive cases, one or the other form will predominate. Briefly described, the characteristic features are as follows:

(a) *Epileptoid (Hystero-epilepsy).*—Immediately upon the appearance of the aura the patient commonly emits a shriek and falls upon the floor or in some convenient place, taking special care to do herself no injury: this is in strong contradistinction to the true epileptic spasm. The head and limbs are thrown about by more or less violent clonic muscular spasms, and at times a condition of opisthotonos or other trunkal contortion (emprosthotonos, pleurosthotonos) may be noticed; these muscular movements, however, are more or less volitional, and are not the aimless movements of the true epileptic. In some cases there is merely a tonic spasm or muscular rigidity. The patient may or may not foam at the mouth. There is a constant twitching of the eyelids and the eyes are rolled about, but apparently retain a more or less observant expression. Consciousness, as a rule, is not fully lost. The facial muscles are distorted, rapid changes of expression being noted (*hysteric trismus*), and respiration is somewhat impeded. As the convulsion passes off the movements gradually subside, and the patient generally sinks into a state of quiescence or, it may be, into a light sleep. This may be followed by complete temporary recovery, or the epileptoid may pass into one of the other forms of the convulsive seizure. The duration of the spasm as described is usually longer than that of a true epileptic seizure. This form, more or less severe, is the one usually seen in this country.

(b) *The Gymnastic Form (Clownish).*—This stage is characterized by violent and grotesque muscular movements. Here are to be grouped all of the more curious manifestations of the disease recorded in the history of medicine. The most difficult feats of the contortionist are performed with apparent ease; the patient may suddenly begin to dance or jump at a most astonishing rate, persisting in the movements until she drops from pure physical exhaustion. The so-called religious ceremonies of the Shakers of Lebanon, Pennsylvania, and of the Jumpers of the Middle Ages are manifestations of this form of

hysteria. In children the attack may appear as the so-called *beast mimicry*, in which the movements or sounds of the lower animals may be simulated; such is also the explanation of the condition known as *spurious hydrophobia*. Consciousness is never lost during this period.

(c) *The Emotional Cataleptic, or Dramatic Form*.—In this form the patient seems to suffer from delusions or hallucinations that are apparently the outcome of the preceding condition. The emotion that is most developed in the patient's moral constitution now dominates his spasmodic actions. As Lloyd aptly expresses it: "The third period of the hysteric convulsion is one of dramatic representation of emotional images, and these are of countless varieties, according to time and person." All of the manifestations of the cataleptic state are present. Sensation is largely abolished, consciousness is retained, and the patient is usually able to recall events that have transpired during the period. Especially common now is the assumption of dramatic and passionate attitudes, which, as described by Richer, include "the attitude of the cross, of defence, of menace, of appeal, of lubricity; of ecstasy, of dread of animals (as rats), of scorn," and the like. The body of the patient retains, at times for indefinite periods, whatever position is first assumed (*hysteric catalepsy*). In some cases the patient falls into a condition of apparent sleep or narcolepsy (*hysteric sleep, hysteric somnolence, hysteric trance*) of varying degrees of intensity; this may persist for any period of time, from an hour or two up to weeks, months, or even years. In these extreme cases, while the patient at first appears to be in a normal sleep, sooner or later the body assumes a corpse-like appearance, with pale, waxy skin, almost imperceptible respiration and cardiac action, and a subnormal temperature.

(d) *The Stage of Delirium*.—The final stage of the hysteric convulsion is but a continuation of the preceding period, with, however, a cessation of the muscular movement to a great extent. The tendency now is to delirium of a mild type, tinged with more or less melancholia. Consciousness is maintained throughout this stage, and there now appear some curious motor phenomena that may persist for days or weeks. These may consist in the abolishment of muscular power in various portions of the body. Very often associated with these motor phenomena is noted a condition of mutism that lasts for indefinite periods of time.

Hysteric paralyses occur, and may simulate any form of the organic paralyses (monoplegia, hemiplegia, paraplegia). In many cases the patient is left with a more or less permanent spasm of a single set of muscles or of associated sets. These so-called *hysteric contractures* may affect any portion of the body. One arm may be bent at the elbow or one leg at the knee; in the former case the fingers are rigidly contracted and embrace the thumb, which is crossed upon the palm, while in the latter the toes are strongly flexed upon the plantar surface and the foot is inverted. The ankle- and knee-jerk persist. In other cases a curious spastic gait is produced that closely simulates that of spinal sclerosis. The muscles of the hips, shoulder, back, and neck (*hysteric torticollis*) may share in the process. In women the muscles of the diaphragm and abdominal walls may be involved (*hysteric pseudocyesis*). *Hysteric rotary spasm, hysteric athetosis*, and *hysteric tremor* are all dependent upon a spasmodic action of the muscles affected. The convulsive seizure generally is of *short duration*, lasting but fifteen to thirty minutes. Occasionally, however, there is developed a prolonged convulsive status, during which time the patient continually falls from one convulsion into another, until one hundred or more may be recorded and the excess of nervous power is exhausted.

(3) *The Latent or Interconvulsive Stage, or Period of the Stigmata*.—After the convulsive attack the patient enters upon a more or less prolonged

interval of comparative quiet; this is characterized, however, by numberless and varied phenomena—the *hysteric stigmata*. The whole course of the affection may be comprised in this period, convulsions being absent. As I have already stated, these can best be described under the heads of the various systems:

(a) **The Nervous System.**—This presents the most characteristic hysteric stigmata. They are generally grouped into the three classes of *motor*, *sensory*, and *psychic*.

The *motor symptoms* have already been referred to in part in the description of the hysteric convulsion. They embrace every variety of muscular pathology, from obdurate paralysis to and including tremor, which may be either fine or coarse, inco-ordination, and tonic spasm or contraction. The hysteric paralyses, as stated, may be absolute or partial, and either general or limited to groups or to individual muscles, and may simulate any variety of true paralysis of organic origin. There is usually noted an exaggeration of the reflexes of the affected side; muscular wasting, if present, is very slight and due to disuse; usually it is absent. It is not at all uncommon to find associated contractures and sensory phenomena. The paralyzed limb or limbs show evidences of circulatory disturbances, as edema and bluish discoloration. In the paraplegic cases it is unusual for trophic disturbances (bed-sores) to appear. Paralysis of muscles supplied by motor cranial nerves, especially those of the larynx and pharynx, may occur; with these exceptions it is usually a pseudoparalysis due to spasm. Hysteric tremors are not infrequent, and are usually well marked and persistent. They are generally associated with contractures and other hysteric stigmata. Choreiform movements may be simulated, but they are usually more quick and rhythmic than true chorea. It is important to remember that hysteria may coexist with chorea; also, that apparently true choreic movements may arise from imitation, in which event it is justifiable to term them hysteric.

Hysteric inco-ordination (*hysteric ataxia*) has also been termed *astasia-abasia*; it is one of the rarest of the motor phenomena of hysteria. The name implies an inability to stand or walk, although muscular power in the legs and trunk is retained, and they can be moved perfectly well when the patient is at rest. *Hysteric contractures* may occur as distinct phenomena or may be associated with some form of hysteric paralysis. Usually the contractures occur with startling abruptness, and are most intense and persistent. They may persist during sleep, but disappear under the influence of an anesthetic. There may be associated sensory phenomena. The toes and the fingers are most frequently the seat of contracture, but the muscles of the face and neck may likewise share in the affection.

Sensory Symptoms.—The anesthetic, hysteric, and paresthetic varieties are noted. The anesthesia may be general or it may involve but half of the body or scattered areas of the cutaneous surface. *Segmental anesthesia* is the term applied to that condition in which a limb or a portion of a limb is involved. Not only is the skin affected, but often the deeper tissues as well, and there is generally some vasomotor involvement, as is shown by the fact that punctures by a needle are not followed by bleeding. There is often associated an anesthesia of one or more of the special senses (*hysteric amaurosis* or *blindness*, *hysteric deafness*, and *hysteric anosmia*). The anesthesia is severe, as a rule, immediately after a hysteric convulsion, but it may be entirely absent throughout a given case of hysteria. There is often contraction of the field of vision or inversion of the color fields, the red being more extensive than the blue. This may also be due to brain tumor.

Hysteric hyperesthesia is also a frequent clinical manifestation, and is generally confined to limited areas, as the ovarian, mammary, or spinal regions,

of rare occurrence (*vide* Angina Pectoris, p. 686). Very frequently the patient exhibits a localized flushing of the skin (*hysteric erythema*), and especially of the face and neck, or, as has already been noted, there may be an apparent bloodlessness of a part. Profuse general or localized sweating is not uncommon, and may at times be bloody.

Hysteric fever may be mentioned here as a rare manifestation, the bodily temperature usually being normal in hysteria. The elevation of temperature may be moderate or there may be an extreme hyperpyrexia (110° to 120° F.— 43.3° – 48.8° C.), without grave results. If this be associated with localized neuralgia, it becomes a difficult matter to diagnose between the neurotic condition and organic disease of the apparently affected part.

(e) **The Urinary System.**—An excessive flow of urine (*hysteric polyuria*) is of very common occurrence, while the opposite condition (*anuria*) is much rarer.

The **diagnosis** of hysteria depends entirely upon the discovery and recognition of the hysteric stigmata; for one or more of them is always present. Of these, the most frequent are areas of anesthesia, concentric narrowing of the visual field and inversion of the color fields, and hysteric aphonia, although any of the others that have been described may occur. If, in addition, hysteric crises are present or have been observed, the diagnosis becomes certain. A valuable feature is the inability to explain the symptoms by reference to the anatomy of the nervous system. It must not be forgotten that hysteria and organic disease may coexist.

Differential Diagnosis.—Very important is it to distinguish between hysteric and true paralyses, and between hysteric and organic abdominal tumors. In the following tables the most striking points of difference between these conditions have been set down:

HYSTERIC PALSIES	ORGANIC PALSIES
Occur without a previous history of organic disease, but with a neurotic history. Traumatism may be the cause.	Are always secondary to organic disease of the neuromuscular system.
Are accompanied by other hysteric stigmata or perversions of sensation.	Hysteric stigmata are absent.
Are not accompanied by wasting of the muscles involved.	If due to a lesion of the peripheral neuron, atrophy is present. In central neuron lesions it is usually not marked.
Reactions of degeneration are absent.	Reactions of degeneration are more or less marked in peripheral palsies. In central, the electric reactions are normal.
The power of motion returns before sensation.	Sensation if absent first reappears.
In hysteric hemiplegia the facial muscles are not involved.	The facial muscles of the same or opposite side are often involved in true hemiplegia.
Anesthesia generally causes relaxation of hysteric contractions.	Organic paralytic contractions are not affected by anesthesia.
The sphincters are rarely involved. ¹	Often are in paraplegias.
Babinski reflex not present.	In central palsies (pyramidal tract) it is present.
HYSTERIC ABDOMINAL TUMORS (PSEUDOCYESIS)	ORGANIC ABDOMINAL TUMORS
Almost invariably occur in neurotic women near the menopause.	Occur irrespective of sex.
The percussion-note is invariably tympanitic.	The percussion-note over the swelling is dull, or a dull tympany.
Anesthesia causes a disappearance of the tumor.	Anesthesia has no effect upon the tumor.
Is variable as to size and tonicity.	Slowly but steadily progresses in size.
Is accompanied by tympany and flatulence.	The bowels are not always distended by gas.

¹ *Arch. of Neurology and Psychiatry*, May, 1919, p. 648.

Hysteric hemianesthesia differs from that due to organic disease in that the special senses and mucous membranes are affected. The line of demarcation is sharp and in the middle line. Tickling the anesthetic mucous membrane of the nose will cause tears to flow, which will not happen if of organic origin, and lateral homonymous hemianopsia is never present. If either the segmented form or scattered areas of sensory paralysis are present, they often have no connection with any known area of nerve distribution. They all may be transient, reappearing and disappearing, and changing their location.

The differential diagnosis between hysteria and true neurasthenia, psychasthenia, and epilepsy will be found in the discussion of these affections.

Prognosis.—As regards death, the prognosis in hysteria is good; true hysteric patients never die of the disease, nor does the hysteric spasm ever result fatally. As to an ultimate cure, however, the prognosis is very doubtful. If the disease occur early in life and if there is a marked congenital neurotic tendency manifested in the patient, there is almost no hope of affecting a permanent cure. In the acquired cases, under proper moral and hygienic control great benefit may be effected or even an absolute cure recorded.

Treatment.—Of the Temperament.—Accurately speaking, the treatment of hysteria should be begun before birth. Neurotic women bearing children should be subjected to a course of rest-cure and mental and moral suasion, and the condition of their nervous systems should receive the careful attention of the attending physician. Neurotic children require the greatest care during the developmental period. A strong physique must be secured by proper attention to out-of-door exercise, and, for the time being, even at the expense of mental culture. Such children should not be subjected to the “cramming” process so common in our modern courses of education, but should be trained, if possible, at home, where the element of competition may be eliminated. Systematic hours of study and of recreation (with absolute rest from study during the summer months), and opportunities of travel and change of air and scene, will work wonders in these hyperesthetic little individuals. Especially at the time of puberty is the greatest of care required in order to avoid an additional strain upon the already seriously taxed nervous system. In addition to the foregoing a strict watch must be kept over the moral nature of the child. The satisfaction of every whim and the lack of moral suasion are the surest ways to develop the hysteric temperament. When possible the child should be taken away from the enervating influences of city life. The diet should be plain, but nutritious, and all overindulgence is to be absolutely prohibited. Frequent bathing and friction of the skin are very beneficial, as well as careful regulation of the emunctories generally.

The Hysteric Convulsion.—As hysteric patients almost never injure themselves during a paroxysm, protective measures are not necessary. Indeed, the attack is usually prolonged by attention and observation. Extreme measures to cut short an attack are only justifiable if the friends and relatives become unduly anxious. Cold plunge-bathing, dashing cold water into the face, or the hypodermic injection of apomorphin, thereby producing a profound mental shock, may have a beneficial effect. Pressure over the ovary or upon one of the large vessels (as the carotid) will sometimes promptly induce a termination of the attack.

Internal Treatment.—In the latent period of the disease it is probable that most can be done to improve the condition of the patient. In addition to the general laws of mental and physical regimen already advanced, she should be taught, so far as possible, the undignified condition into which she is sinking, and advised and encouraged to exert powerful efforts to control her nervous organism. All harsh methods are to be deprecated, nor should she, after the

first admonition, be reminded too constantly of her condition. Full doses of the nerve sedatives and antispasmodics (valerian, asafetida, sumbul, musk, and camphor), together with the general tonics (iron, arsenic, strychnin), are useful. Change of environment, and particularly of associates, is often of the greatest value. I have repeatedly found the rest-cure of Weir Mitchell especially beneficial at this time; it is fully described under Neurasthenia (*vide* p. 1187).

Suggestion and persuasion are valuable means of causing the removal of symptoms.

In the treatment of the organic manifestations, which, it must be remembered, are dependent entirely upon the general nervous condition, the physician is called upon to exercise the greatest amount of tact. As far as is possible the mind of the patient must be directed away from the affected part. The *irritable bladder* must be treated by internal remedies, as atropin, boric or benzoic acid, salol, or the compound infusion of buchu, and not by local irrigation and catheterization.

Hysteric vomiting may not require any special medication. Occasionally, however, it may be relieved by rectal alimentation or gastric lavage. Cocain hydrochlorate in the form of a 10 per cent. solution (3 to 5 drops internally), and the application of mild counterirritation or of a small fly-blister over the epigastrium will be useful. Cannabis indica, acetanilid, phenacetin, and antipyrin, in small doses and only when absolutely needful, will relieve *hysteric neuralgias*, especially the cephalalgia. For the pseudo-angina pectoris, digitalis, strophanthus, caffein, amyl nitrite, or nitroglycerin, or a combination of these drugs in suitable doses, may be exhibited.

For the *pelvic hyperesthesia* of hysteric females local applications (tincture of iodine, croton oil, or a small fly-blister) over the ovarian region may prove very beneficial.

Hysteric palsies, either general or local, and hysteric disturbances of the special senses, must be treated on general principles. As far as is possible the patient's attention must be directed from the affected part or parts, and an occasional local blistering, the use of galvanism and massage, with daily friction, will be of service, especially when they are supplemented by an appropriate course of internal medication.

Electricity is a very valuable adjunct. The static current is most effective, and it may be applied in various forms. Perhaps the most useful of these is the spark, which should be drawn from the anesthetic area or the paralyzed limb, thus producing a profound mental effect.

Analytic or Cathartic Method.—Based upon the theories of Breur and Freud (p. 1175), this method has been evolved. Briefly, it consists in getting the patient "to tell the story of his life." In other words, while in a relaxed condition (reclining on a couch) he is encouraged to make a confession of all the disagreeable happenings of his life. This may require some time and a number of sésances. Clues to these may be obtained from the description of the patient's dreams. Gaps may have to be filled in by the physician by some method of psycho-analysis. After the so-called mental catharsis has occurred, method of psycho-analysis. Those who employ the method claim that after the so-called mental catharsis has occurred, the cause of the trouble being so determined, the patient usually recovers.¹

¹ *Psychanalysis*, Brill, W. B. Saunders Co.

NEURASTHENIA

Definition.—Functional exhaustion and irritability of the nerve-centers. Neurasthenia is the expression of an abnormal sensitiveness (irritability) in response to stimuli, and of weakness of the nerve-centers presiding over the organic functions. Several varieties—cerebral, spinal, cardiac, and gastric—have been distinguished, owing to the fact that the predominating features may be manifested by single organs or systems of the body. That the disease is essentially generalized in all instances, however, I do not doubt.

Pathology.—A variable degree of weakness of the sympathetic centers, permitting congestions on trivial provocation, is obvious, but there are no discoverable lesions (coarse) in the nerve-centers that are peculiar to the affection. C. Y. Hodge¹ has invited attention to certain changes in nerve-cells during the active exercise of their function, and something of pathologic importance has been added to our previous knowledge by his observations. There are many causes and associated affections that present a variety of morbid lesions, but they are purely incidental. It should be pointed out here that neurasthenia is often found in association with other functional nervous disorders—a fact that has not only caused mental confusion among certain authors, but has also led to the belief among others that as a distinct affection it does not exist. Glénard in 1888 called attention to the frequent association of profound neurasthenic symptoms with splanchnoptosis.

Etiology.—The causes are divisible into: (1) predisposing; and (2) exciting. Among the former (a) *heredity* heads the list. A clear history of nervousness or morbid irritability in one or both parents (oftener the father) is at times obtainable. Ancestors that were sufferers from gout, rheumatism, syphilis, tuberculosis, and chronic alcoholism, all diseases that exhaust vitality, may have transmitted to their offspring a strong neurasthenic disposition. The latter have inherited a small stock of nervous energy with which to begin life's unceasing struggle.

Other predisposing factors are—(b) improper training, mental and physical, (c) the character of the mental pursuits, those entailing strains being especially deleterious. (d) *Age* and *sex* are not without appreciable effect, most cases occurring between the twentieth and fiftieth years, when the work and worry of life are maximal; they are more frequent in men than in women, and (e) disturbances of metabolism accompanied by an abnormally low output of endogenous uric acid (Peck and Thompson).

Exciting Causes.—*Traumatism* has an active potency, though it is probably not the most frequent cause. *Orcerwork*, at least in America, is responsible for a greater number of cases than any other single factor, and in estimating its effects the relativity of individual nerve capital must be carefully considered. Associated causes are to be observed in unpleasurable emotional excitement, mental worriment, particularly if dependent upon love affairs and sexual excesses. *Abuse of the sexual organs*, excessive venery, masturbation, coitus interruptus, and the like are powerful in producing neurasthenia. Finally, as stated under Pathology, the condition may be induced by other functional and organic affections (symptomatic neurasthenia). (Also see Vagotomy, p. 1068).

Symptoms.—The subjective symptoms are protean and varied, and are usually described with great detail, for the patients are, as a rule, exceedingly voluble. Among the more prominent features entering into the symptom-complex of neurasthenia are great *irritability*, *physical fatigue* without adequate reason, even to a feeling of utter exhaustion on rising in the morning, *disturbed sleep*, *headache*, with a sense of weight and constriction, *impairment of memory*, *anorexia*, and *constipation*; the patient is very irritable, dispirited, is fearful, and frequently sinks into a state of absolute dejection. Female sufferers—

and less frequently males also—may manifest strong emotions, and in such cases the condition presents many points of resemblance to the milder forms of hysteria. The external appearances may be indicative of sound, vigorous health; oftener, however, the physiognomy is worn and anxious.

The **motor phenomena** include, besides readily oncoming exhaustion of the muscular strength under exercise, a variable condition of the tendon reactions. On the whole, however, they are increased. Muscular *tremors* (fine) are sometimes present when neurasthenia is the result of trauma or fright (Dercum), and spasmodic contractions of small isolated groups of muscular fibers of the face, trunk, or extremities are observed.

The **sensory disturbances** are varied and sometimes striking. The patient makes constant complaint of feeling "tired" or "never rested," and indeed sometimes betakes himself to bed for this reason. As a rule he feels more tired in the mornings after rising than upon retiring at night. A feeling of "lightness," giddiness, and even true vertigo, may occur and recur, and rarely the latter symptom is wellnigh continuous. The *headache* (previously mentioned) is often wholly dependent upon mental work, since it disappears with the cessation of the latter. Another form of *pain* is a dull aching that may be generalized, though more commonly it is confined to the small of the back and limbs. *Spinal tenderness*, when sought for, may often be elicited over certain circumscribed areas or mere points, and it may be combined with deep-seated ache or an exacerbating pain ("spinal irritation"). Cutaneous *hyperesthesia* is common, but anesthesia is not found in uncomplicated neurasthenia. Numbness, either spontaneous or as the result of slight pressure, is a conspicuous feature for a variable period upon or near the nerve-trunks, and linked with it there may be a generalized or localized feeling of coolness of the body surface, or of pricking sensations (formications) and circumscribed subjective sensations of heat and burning.

The *psychic* symptoms grow out of the same fundamental conditions as do the *physical* symptoms—i. e., fatigue of the nerve-centers. As would be expected, then, the capacity for sustained mental work is generally lessened, and the power to concentrate or rivet the attention upon any subject as well. The patient is self-centered, sensitive to a degree, easily angered, and is morbidly suspicious. His emotional nature is unstable, and the mental depression (before mentioned) deepens until it approaches true hypochondria.

Insomnia is one of the most constant and troublesome of all the symptoms of neurasthenia. It occurs in various forms. Usually the patient goes to sleep readily, but awakens in a few hours and remains awake either for the rest of the night or until morning is approaching; sometimes there is difficulty in falling asleep; sometimes rest is frequently disturbed. Agrypnia, total inability to sleep, occurs only in the most severe forms of the disease. Disturbances of the organs of special sense are not wanting. The eye presents the most important fatigue symptoms. *Vision* may be imperfect (blurred) and continuous close use of the eyes may be impossible. There is a lack of power of accommodation and retinal hyperesthesia may supervene. The pupils may be unnaturally large. All forms of *tinnitus* constantly arise in neurasthenia, and may lend so vivid a coloring to the clinical picture that the real nature of the attack is liable to be overlooked. I have recently seen a case of the sort occurring in a clergyman in whom aural disease had previously been diagnosticated. This symptom, like all others due to neurasthenia, may, however, be associated with genuine organic diseases of the ear (*otoneurasthenia*). Disturbances of taste sometimes appear, but they are of minor importance. *Vasomotor* disorders, such as hot flushes and profuse sweats, commonly arise in consequence of the diminished tone of the arteries; these form quite distressing fatigue symptoms. Visible throbbing of the superficial vessels and of

the abdominal aorta, and rarely also of the veins and the capillary pulse, occur. The *urinary phenomena* may excite particular attention owing to their prominence, and this remark applies especially to the frequent combination of neurasthenia and lithemia (*lithemic neurasthenia*). Oxaluria and transient glycosuria and albuminuria may also be present. The daily amount of urine is often small, and less frequently it is large. The sexual apparatus is weak and irritable, as shown by seminal emissions and incomplete erections, and by premature ejaculation. The fear of becoming impotent often renders the mental attitude of those really potent such as to excite the keenest compassion. The orgasm in the female and the emission in the male are followed by a sense of prostration and mental depression.

The somatic disturbances referable to the heart (palpitation, precordial pain) have been considered under Neuroses of the Heart, and the various gastro-intestinal features in the discussion of Neuroses of the Stomach. Reference has already been made to several clinical varieties based upon the predominance of special and localized groups of symptoms—*e. g.*, when the reigning features are spinal the variety is termed *spinal neurasthenia*; when these are presented by the sexual apparatus, *sexual neurasthenia*, and so on. A further subdivision has recently been made in which the predominant symptoms are various morbid fears, imperative ideas, impulsive acts, and the so-called doubting mania. This has been termed *psychasthenia* (p. 1190). The most obstinate type of neurasthenia is that associated with congenital defects of structure, particularly splanchnoptosis, the so-called Glénard's disease. It does not differ essentially from the ordinary forms, but the gastro-intestinal symptoms predominate.

Diagnosis.—That cases of neurasthenia are misdiagnosed as other conditions, and the reverse, I feel convinced. An important matter at the outset is to avoid confounding the neurasthenic symptoms (secondary) of various local and general organic diseases with the primary form by a careful exclusion of the latter. From *hysteria* the diagnosis is as follows:

HYSTERIA	NEURASTHENIA
By nature a psychoneurosis.	A neurosis; often with a pronounced psychical element.
Occurs in individuals presenting a marked hereditary taint.	Occurs as the result of nerve tire, overwork, and the like in individuals not necessarily presenting hereditary taint.
The onset is frequently abrupt.	The onset is always gradual.
The clinical features are dependent upon an excess of nervous energy.	Is characterized by a notable lack or insufficiency of nerve force.
Presents the characteristic stigmata, as paralysis and anesthesia in most cases.	These are absent.
Is sometimes accompanied by violent convulsive seizures.	Convulsive seizures never occur.
Neuralgic attacks infrequent and absent.	Neuralgic attacks are very common.
Insomnia is not marked.	Insomnia is very common.

Hysteria, it is to be remembered, may be a complication of neurasthenia, and this association must be distinguished from simple hysteria. Neurasthenia must also be distinguished from psychasthenia (p. 1190). It should also be remembered that neurasthenic symptoms may mark the commencement of various grave physical and mental disorders. Tuberculosis, diseases of the blood, dilated stomach, gastric cancer, gastropptosis, movable kidney, focal infections, chronic uterine and ovarian disease, paresis, dementia præcox, hypochondria, pellagra¹ (p. 444), and melancholia should all be considered before the diagnosis of pure neurasthenia is made. Timme has called attention to a group of cases beginning in early life in which there is *abnormal muscular*

¹ Tucker, *Amer. Jour. Med. Sci.*, March, 1912, p. 332.

fatigability, recent or concurrent rapid growth, frontal headache, low blood-pressure, low sugar content of the blood, hypopituitarism, and persistence of the thymus. There is a tendency to emotional instability and various phobias and convulsions (p. 1190). The administration of pituitary gland may give relief or spontaneous cure may occur after a number of years by the occurrence of hyperpituitarism.¹

Prognosis.—Neurasthenia is a curable disease if appropriate treatment be commenced before secondary structural changes set in and render the use of the most approved measures of no avail. In long-standing cases deleterious habits (morphinism, chloralism, alcoholism) are sometimes developed and prevent the possibility of a cure. Hysteria (the complication) tends to delay, but does not preclude, recovery.

Treatment.—The first step should be, after locating the major cause or causes, to remove them, or, if this be impossible, to minimize their baneful influence so far as may be. For example, if the conditions have been induced by overwork of the brain, rest for the organ must be procured; if sexual excesses have been the obvious responsible factor, rest for the sexual apparatus is imperatively demanded. In the next place, the mental and moral environment must be conducive to contentment and to wholesome forms of exercise of the mind. In this way the exhausted stock of nervous energy can often be increased by the natural recuperative forces alone. Indeed, successful removal of the essential etiologic influences is in the milder forms followed by prompt recovery. In not a few instances the symptoms disappear as the result of a prolonged sojourn in a suitable climate or by travel for a considerable period with its ever-accompanying change of scene, though it is well in doing so to avoid the din and excitement of large cities. The compulsory rest and complete isolation, combined with the purity of atmosphere, afforded by a sea-voyage sometimes work admirable results. Being occupied by easy and agreeable employment under supervision, as embroidery, basket-making, etc., has been successful. Unfortunately, many subjects suffering with neurasthenia, and particularly males, are either unable or unwilling to arrest the loss of nervous function by ceasing their excessive activities. In the majority of instances, for the reasons above stated, certain other measures—hygienic and medicinal—are to be advised.

To Dr. Weir Mitchell belongs the credit of having systematized the "rest-cure" in the management of this disease. This mode of treatment involves (1) physical and psychic rest. The former is obtained by strict confinement to bed, the latter by isolation from all business, professional, household, and family affairs; in severe cases, to the complete exclusion of the family. (2) Hypernutrition. This requires the administration of a quantity of food in excess of the amount required merely to maintain life and repair waste, and is usually secured by feeding at frequent intervals and using nutritious food. (3) The stimulation of the metabolic processes. This is accomplished by massage, passive movements, and electricity. (4) The encouragement and education of the patient. This depends largely upon the tact and authority of the physician and nurse, although graduated and increasing voluntary muscular and mental exercises are of some value. In long-standing cases rest should be made absolute if possible, while in the milder forms merely lengthening the hours for sleep or rest in bed often suffices. The amount of rest must be accurately proportioned to the necessity of each case.

The patient is to be put in charge of a properly selected nurse, who will afford agreeable entertainment by suitable conversation and reading under the direction of the physician. In desperate cases the patient should not be

¹ Abstract, *Archives of Neurology and Psychiatry*, April, 1919, p. 505; *Endocrinology*, July-September, 1918.

allowed to feed himself, must not rise to void the urine or feces, nor even turn in bed without the help of the nurse.

Upon the careful regulation of the *diet* depends, to a large extent, the success of the treatment. This must be modified to suit each individual patient, and, when it is possible, it is desirable first to make a careful quantitative and qualitative examination of the stomach contents.

The two commonest derangements are excess of hydrochloric acid, with retention of stomach contents and anacidity.

In the former condition the diet must consist of the lighter meats, the more readily digested vegetables, particularly the legumes, the cereals, light desserts, toasted bread, crackers, etc., a liberal amount of fat and milk, and eggs in moderation. I have rarely found it necessary to commence with a very restricted diet of, say milk; but, as a rule, the patient can begin on three full meals a day, with a luncheon consisting of milk and toast or crackers, malted milk, chocolate, or cocoa, etc., in the mid-morning and mid-afternoon, before going to bed, and, in severe cases, also once during the night. These cases are also benefited by the administration of moderate quantities of soda after each meal.

In the achylic form the total quantity in each meal should be somewhat less, but from six to eight meals may be given in the course of twenty-four hours. The diet should consist of meats, eggs, the legumes, the acid vegetables, the cereals, bread, fruit, light desserts, a moderate amount of coffee, and a liberal amount of milk. Hydrochloric acid should be given before each meal. In either case the caloric value of the diet should exceed 3000 in the course of twenty-four hours.

In cases in which the gastric analysis is not possible, it is of advantage to commence with small quantities of food, and to increase them rapidly until a very liberal diet is being taken. As a general rule the red meats should not be given too frequently, the coarser vegetables should be excluded entirely, and sweet food should be taken sparingly. Most cases do well on cream taken in quantities of 4 to 8 ounces at a time, sipped slowly, while, at the same time, crackers or toast are eaten.

It is, of course, understood that the patient should never be consulted about the diet. The nurse brings the food at the proper time, served in the most attractive manner possible, and at meal-time always in courses, so that only moderate amounts of food are placed before the patient at one time. The patient should lie perfectly flat for at least an hour after eating.

Passive exercise, massage, and electricity form an essential part of the "rest-cure." Massage should not be commenced until the second or third day. At first it should be continued for a few minutes only, and consist of gentle rubbing or light strokes. As tolerance becomes established, it should be practised for a longer period (about an hour). Deeper rolling, kneading, and spiral manipulations are then allowable. The direction of the venous blood-current—toward the center of the body from the periphery—is to be borne in mind, and all massage motions are to be made in the same direction. This measure is to be carried out by the nurse, who should be a well-trained masseuse and thoroughly acquainted with the details of her work. Electricity, like massage, compensates for the lack of exercise. The slowly interrupted faradic current is to be selected, and the aim should always be to induce satisfactory contractions with the least amount of pain. The current should be applied to the individual muscles, one of the extremities being selected, and the poles applied over the motor points, passing from muscle to muscle until all have been faradized. The time of each sitting should not exceed half an hour. The entire body should also receive the faradic current (rapidly interrupted). A large sponge moistened with salt water is applied at the nape of the neck.

and another to the soles of the feet, and the strongest current tolerable is thus used. This process should be continued from fifteen to twenty minutes, and, like the faradization of the single muscles, it is to be repeated at intervals of twenty-four hours. Passive movements should be employed systematically, slowly increasing in duration and extent. They promote circulation and nutrition and are soothing.

Hydrotherapy may be employed in the form of the shower, spray, bath, or pack, and is most efficacious when quickly applied for a few moments and followed by vigorous toweling to reinforce the action of the cold. In insomnia with difficulty in going to sleep, the dry cold pack applied to the spine for an hour is often of benefit. Extreme caution is necessary at the beginning of the application of cold to the surface, since there are neurasthenic subjects who not only fail to receive benefit, but are rendered worse in consequence of a highly sensitive organization.

Although the administration of *drugs* plays a minor part in the management of the rest-cure, in certain cases they are essential, and must not be excluded. Alkalies or acids are indicated, according to the condition of the stomach contents. If there is excess of acid, the alkalies may be taken after meals; if there is a deficiency of acid, hydrochloric acid should always be given before meals, and in ample doses—from 10 to 20 minims of the dilute acid.

The most important drugs are the laxatives. In the beginning calomel and the salines are often of great value in flushing out the intestines, but during the course of the disease it is the invariable rule never to purge. Of the vegetable laxatives cascara is probably the most useful, but aloin and rhubarb are often of service. Of the saline laxatives the most efficient are certain forms of magnesia and phosphate of soda. In cases where there is considerable alkalinity from 5 to 10 grains of oxid of magnesia in powder form may advantageously replace the soda after meals. Or 1 or 2 drams of the milk of magnesia may be given in milk, two or three times a day. Small doses of phosphate of soda in hot water should be given just before breakfast in the morning, being carefully regulated so that only a laxative effect is produced.

If there is pronounced anemia, moderate doses of iron, perhaps combined with arsenic and the bichlorid of mercury, are often of service, but must be discontinued if they interfere with the appetite. There is considerable dispute regarding the value of phosphoric acid, or its salts. According to my experience, it is of comparatively little value.

The rest-cure in all of its details should be continued for a period ranging from four to eight weeks. The patient should leave his bed in the most gradual manner, and should sit up for a few minutes only at first, the time being gradually lengthened; soon exercise may be commenced in a like manner and be cautiously increased. During this period of convalescence it is my custom to omit the electric treatment, while the massage is continued at intervals of two or three days for some weeks. After the patient has made some improvement, as evidenced by a large appetite, the disappearance of the most pronounced subjective symptoms, and especially by a substantial gain of weight (20 to 25 pounds—11.3 kgms.), he should be advised to make a change of residence, preferably to the country, the mountains, or the seashore, being guided by the season and the wishes of the patient.

We must increase the activity of the metabolic processes in cases in which the endogenous uric acid output is lowered (400 gr. or less daily). Peck and Thompson advocate the use of the electric-light baths. Cases which are not able to undergo these methods (they being somewhat expensive) must be treated symptomatically, small doses of the bromids, combined with arsenic, if irritability is excessive. Cold douches or baths, with vigorous rubbing in the

mornings; tonics, as the glycerophosphates, iron, etc., attention to the gastrointestinal tract, encouragement, regulation of the employment, as much fresh air as possible, electricity in the form of high-frequency currents, etc.

TRAUMATIC NEUROSES

Owing to the marked influence of trauma in causing both neurasthenia and hysteria, such cases are often specially classified under the above title. The symptoms are, however, essentially those of either hysteria or neurasthenia, or both combined. The general rules of diagnosis and prognosis in these conditions here apply. It should be remembered that the strain incident to litigation, to which these cases are often subjected, may retard recovery.

PSYCHASTHENIA

A group of symptoms, until recently classified under neurasthenia, has been given the above title. They consist of obsessions, fears, doubts, undue anxiety, uncontrollable movements, deficient will-power, combined with more or less of the physical symptoms of neurasthenia. As examples of these mental symptoms may be mentioned dread of impending danger, either to family or self, fear of open spaces (agoraphobia), fear of closed places (claustrophobia), of being alone (monophobia), fear of crowds, abnormal fear of storms, of wind, etc.; fear of personal defilement (mysophobia); the doubting mania, in which the patient is never certain that he has performed an action correctly; irresistible impulse to touch certain objects (*delire du toucher*); irresistible tendencies to repeat continually certain words (onomatomania), to count a certain number of times before performing an action (arithmomania), etc. The patient is conscious of the absurdity of these actions and feelings, but cannot resist them. Epileptiform convulsions may also occur. The prognosis is doubtful, but treatment similar to that recommended for hysteria may achieve good results. The possible existence of disturbance of the functions of endocrine glands must be remembered (p. 1187).

OCCUPATION-NEUROSES

Definition.—Conditions in which the performance of certain habitual co-ordinated movements is prevented by the development of cramp, tremor, paralysis, or pain.

The **pathology** of this condition is unknown. It is probably purely functional, and the discovery of appreciable lesions is not to be expected, though nodular thickening of the peripheral nerves has been described in a few cases.

The **etiology** is various. Those following any occupation requiring the continuous repetition of fine, co-ordinated, muscular movements, as sewing, type-writing, playing musical instruments, telegraphing, and writing, may be affected. Writing is the most common cause, and is known as scrivener's palsy or writer's cramp. It is the form here particularly described, although the symptoms due to other causes are similar. Males are far more frequently affected than females, the condition usually occurring in early adult life, although children are not exempt. Gowers lays great stress upon improper methods of holding the pen, particularly those in which most of the writing is done from the wrist; that is, with the muscles of the forearm and hand. As scrivener's palsy occurs sometimes in those that write properly, and as a similar condition is not uncommon in other occupations, it seems unlikely that this is the most important cause. A person with a neurotic temperament is far more apt to be affected by the disease than one with a normal nervous system;

ve, therefore, frequently find it associated with hysteria, neurasthenia, or great washfulness, and not infrequently it is possible to elicit a neuropathic heredity in the family history. It is also met with in certain other nervous diseases (epilepsy, locomotor ataxia—in the early stage). Often the patients admit that at the time the disease developed they were suffering from severe anxiety.

Symptoms.—Motor.—When the patient attempts the particular movements involved there is usually a cramp of the flexor muscles of the forearm, so that in writing, for instance, the pen is held more or less rigidly, and it is almost impossible to control its motions. Less frequently there is a cramp of the extensor muscles, so that the fingers are spread and it is impossible to hold the pen at all. Sometimes there is a sudden twitching, and the pen may be thrown altogether out of the hand. The spasm is nearly always tonic in character, but often it is associated with a fine tremor, and at times there are clonic movements. In some cases, and particularly those occurring in patients showing hysteric stigmata, there is a coarse, irregular tremor, most marked when the patient is under observation. Paresis is frequently associated with the cramp, so that the arm soon becomes tired and it is almost impossible to write. This fatigue may in a few moments progress to almost complete paralysis of the arm, but, curiously enough, both fatigue and paralysis disappear as soon as some co-ordinated movement other than writing is undertaken.

Sensory.—Pain is very common, and is neuralgic or cramp-like in character, being referred either to the muscles, bones, or joints. In intensity it varies from a dull ache to the most excruciating burning, and may form the only symptom, the muscles performing their work perfectly. At times it is sharply localized to one particular joint, affecting either the metacarpal bones or the fingers. Quite often the patient complains of a tingling or burning sensation in the limb, or it may be numb and the hand feels, when writing, as if a heavy weight were attached to it. Often there is tenderness either of the muscles or the nerves, which may be localized in certain points. In very severe cases *vasomotor disturbances* occasionally occur. The disease ordinarily commences slowly. At first the subject notices that the handwriting is not quite as perfect as before, a stroke occasionally going astray; later distinct spasms appear, and these are finally associated with pain.

The **diagnosis** is usually easy. Care must, however, be taken not to call every disturbance of writing writer's cramp; thus in paralysis agitans, in slowly developing hemiplegia, in multiple sclerosis, and paresis disturbances of writing frequently—in fact, almost invariably—occur. Moreover, those cases in which hysteria or neurasthenia seems to be at the bottom of the trouble should be carefully differentiated from those that are apparently idiopathic.

The **prognosis** is rather unfavorable, though complete cure is sometimes attained.

The **treatment** consists first in a total cessation of the particular movements; if this is impossible, various mechanical devices may be employed to use another set of muscles or the old ones rather differently, such as a thick penholder or one constructed with supports for the fingers. Local treatment of the arm in the form of electricity should be advised; the anode of a constant galvanic current of medium intensity should be placed over the sensitive points on the nerves and over the bodies of the muscles. The wire brush employed, with the rapidly interrupted faradic current, to stroke the painful nerves and muscles, affords great relief. Massage, and particularly careful and systematic exercises, are also of great value. At the same time, the general condition of the patient must not be neglected. In those associated with neurasthenia a treatment appropriate to this condition should be employed.

ACROMEGALY

(Giantism)

Definition.—A disease first recognized and described by Marie, and characterized by a progressive and peculiar enlargement of the face and extremities.

Pathology.—Those cases that have been examined *postmortem* have shown, as the most constant change, an enlargement of the pituitary body, with a corresponding dilatation of the sella turcica, and a persistence of the thymus gland. Alterations may be found in other ductless glands, especially the thyroid, which may be either goitrous or atrophied. In some cases the pituitary may not be enlarged macroscopically. The lips, tongue, and trachea are usually considerably enlarged, and the sexual organs may either be hypertrophied or atrophied, the latter condition being more common in the uterus and testicles. The bones of the extremities and face are thickened, apparently chiefly as a result of hyperplasia of the spongy portion, and Klebs has shown that the peripheral vessels, particularly those in the affected bones, are also larger. Occasionally there are hypertrophy of the heart and enlargement of the spleen and liver.

Acromegaly is due to an increased activity of the anterior lobes of the pituitary body occurring after epiphyseal union has taken place. If it occurs before this (in childhood) *gigantism* is the result. In this changes in the pituitary will be found similar to those occurring in acromegaly. Of 183 cases of pituitary disease in which the urinary findings were given, 88, or 42.6 per cent., showed acromegaly.¹

Cushing² has described cases in which with overgrowth are associated symptoms of posterior lobe insufficiency, *i. e.*, adiposis, increased sugar tolerance, polyuria, polydipsia, subnormal temperature, dry skin, loss of hair, epileptiform disturbances, etc. He believes such cases are due to anterior lobe hyperplasia associated with posterior lobe hypoplasia.

Both sexes are about equally affected, and the disease ordinarily commences in adolescence.

The earliest **symptom** is usually an increase in the thickness of the fingers and toes, so that rings, gloves, and shoes are too small and can no longer be worn. This *enlargement* is chiefly in thickness, although there is also a certain amount of increase in length. Both the soft and hard parts are affected. The nails are flattened, longitudinally ridged, and more friable (*spade-like hand*). The *face* becomes considerably enlarged; the supra-orbital ridges project, giving rise to a rather simian aspect; the nose becomes broader and longer; the cheek bones project; but the most positive characteristic is the enormous enlargement of the lower jaw, so that it becomes broader and prognathous, and the lower teeth can no longer be brought in apposition with the upper. The *spinal column* is ordinarily kyphotic, the change affecting the upper dorsal and cervical regions. Frequently there is also an associated scoliosis. The rest of the skeleton remains unaffected for a long time; finally, changes may be observed in the clavicles, sternum, ribs, pelvis, and particularly in the patellæ. The *skin* sometimes shows slight pigmentation; the hair is rough and may become thinner; the *muscles* occasionally exhibit increased electric excitability, and less frequently there is muscular atrophy with reactions of degeneration. The lips, tongue, and tonsils are usually enlarged, and the larynx is increased in dimensions, so that the *voice* becomes deep and rough;

¹ "Relation of Glycosuria to Pituitary Disease," by J. M. Anders and H. L. Jameon, *Amer. Jour. Med. Sci.*, September, 1914, p. 313.

² *Amer. Jour. Med. Sci.*, March, 1913, p. 313.

this is a very characteristic symptom in women. Ordinarily, an area of dullness can be detected in the upper part of the sternum that has been ascribed to the persistence of the thymus gland. The *tendon reflexes* may either be normal, diminished, or abolished. They are never exaggerated. The *urine* is increased in amount, and glycosuria is often present. The secretion of *sweat* is also greatly increased. The subjective symptoms consist of severe intermittent or continuous *headache* and of a *diminution of the visual power*. There may be paresis of the third nerve, giving rise to external strabismus, and sometimes to *temporal hemianopsia* as a result of pressure upon the central part of the chiasm by an enlarged pituitary body. Sometimes late in the disease there are occasional momentary general tremors. The patients often present polyphagia and polydipsia. Neuroretinitis and subsequent atrophy of the optic nerve may also occur. The mental condition is affected, and there are usually great apathy and diffidence (perhaps explicable by their changed appearance), loss of memory, and somnolence. Symptoms of either myxedema, exophthalmic goiter, syringomyelia, or epilepsy may coexist.

Diagnosis.—In the later stages the appearance is characteristic, and acromegaly can then hardly be confounded with other diseases. The peculiar enlargement of the extremities, the oval, prognathous, and distorted face, the deep, rough voice, the more or less pronounced pigmentation of the skin, the wasting of the muscles, and the profound cachexia give a perfect clinical picture. In those cases in which the cachexia has become extreme there are from time to time peculiar tremors or spasms of the body.

Differential Diagnosis.—In the earlier stages the disease is most easily confounded with the *hypertrophic pulmonary osteo-arthritis of Marie*. In this both hands and feet are greatly enlarged; but the fingers are club-shaped, the face is not involved, and there usually exists some chronic pulmonary complication. In a case that I observed there were bronchiectasis and bronchorrhea. From *osteitis deformans* it may be distinguished by the fact that in this condition chiefly the long bones of the limbs and the flat bones of the skull are hypertrophied and very painful. *Elephantiasis* may be distinguished by the fact that it attacks the lower limbs, does not involve the bones, and the skin presents a granular or a nodular appearance. From *arthritis deformans* acromegaly may be distinguished by the fact that the disease is painful, and is associated with great deformity of the joints, the face ordinarily escaping. The following table (after Dercum) will serve to distinguish two diseases that are apt to be confounded with one another:

ACROMEGALY	MYXEDEMA
Occurs most commonly in early adult life.	A disease of mature life—forty to fifty years.
In males and females equally.	Five times as frequent in females as in males.
Enlargement of the bones characteristic. Marked prognathism of jaw and flattening of cheeks.	No enlargement of the bones. Face full-moon shaped.
Skin brownish yellow; hair coarse and unwieldly; nails short and striated.	Skin pale, waxy, shiny, and boggy; hair falls out; nails not affected.
Fingers symmetric and sausage shaped.	Fingers clubbed at the end.
Administration of thyroid extract is of the smallest benefit.	Thyroid treatment of the greatest benefit.

A skiagraphic examination is of great value in doubtful cases, as enlargement of the sella turcica will usually be found.

The **prognosis** is hopeless for cure and doubtful for duration. The disease is progressive, although it remains stationary for a longer or shorter

period. Retrogression never occurs. Ordinarily the patient dies of some intercurrent condition, although death may be due to the cachexia of acromegaly itself. Life, however, may last for twenty years after the appearance of the first symptoms.

Medical treatment of the condition has proved unavailing. Extracts of both thyroid and pituitary glands have been used with not encouraging results. Removal of the pituitary gland, if the seat of tumor, has been done with good results in some cases. The cephalalgia may be more or less completely controlled by antipyrin or caffeine. Goodhart¹ has reported a case in which relief was obtained from a right subtemporal decompression. Phosphorus, mercury, the iodids, and arsenic have been useful in some cases. Nordentoft describes excellent results from roentgenotherapy, the subjective disturbances subsiding and earning capacity being regained, although the acromegalic changes are stationary.

OXYCEPHALY

Definition.—This has been defined by Osler as a cranial deformity associated with exophthalmos and impairment of vision.

Pathology.—The condition is due to a premature closing of the sutures, especially the coronal and sagittal. Bertolotti, of Turin, considers the underlying cause to be a lymphatic polyglandular dystrophy with hypertrophy of Waldyer's ring and lesions of the hypophysis, thyroid, and gonads. The influence of syphilis is not apparent. The headache and papillitis are due to increased intracranial pressure.

Symptoms.—The characteristic deformity is an increased height of the skull. This is usually found in the frontal, but may be in the parietal, region, and slopes to a pointed vertex. The shape resembles more or less a tower or steeple. The supra-orbital ridges are feebly marked and the hair-line of the scalp is much above the normal level. It is usually found at birth, but may not develop until early childhood. The skull may be asymmetric. As a rule exophthalmos develops sooner or later, but may be absent. When present it does not show the lid symptoms of exophthalmic goiter. In the early stages papillitis is present, which goes on to optic atrophy and blindness. Headache and convulsions are also frequent at this period. Active symptoms which may be present are strabismus, keratitis, ectropion, lagophthalmos, panophthalmitis, palpitation of the heart, tachycardia, and vomiting. Intelligence is not impaired. The deformity is usually well brought out by x-ray examination.

Prognosis.—The earlier the symptoms develop, the more severe they are likely to be. Blindness is very frequent and most patients die before reaching the age of fifty.

Treatment.—When symptoms of intracranial pressure exist cranial decompression may be of service. Lumbar puncture when such symptoms are present is dangerous and may cause sudden death.

¹ *Neurolog. Bulletin*, April, 1919, 168.

ADIPOSIS DOLOROSA

This disease was first described by Dercum, of Philadelphia, in 1888. It may be defined as a condition in which masses of fat are deposited irregularly in the subcutaneous tissue of the body, with tenderness and spontaneous pain in these masses, and derangement of the menstrual functions. Several cases, including the one first described by Dercum, have been examined post-mortem, and a variety of changes have been found. The fat is usually denser than ordinary fat, due to the presence of a considerable amount of fibrous connective-tissue trabeculae. The thyroid glands are sometimes small and sclerotic, and, in the case recorded by Burr, there was a tumor of the pituitary body. Many of the symptoms suggest hypopituitarism. The cutaneous nerves show a moderate amount of degeneration, sometimes associated with interstitial neuritis. The main nerve-trunks are usually normal. Hemolymph-glands have been found in the fatty tissue.

The **etiology** of the condition is unknown. It has been ascribed to an early climacteric, and to the changes in the thyroid gland, but it is not understood how either condition could give rise to the clinical feature of adiposis dolorosa. It occurs almost exclusively in women.

Symptomatology.—Some time in adult life the patient begins to grow stout. This condition gradually progresses, and the patient notices that the fat is more or less irregularly distributed, appearing first in one and then in another part of the body, and that in the places in which it appears there are severe pains of a burning, shooting character. Finally, the masses of fat become huge; as a result of their weight they become pendulous; they are elastic, give an indistinct sense of fluctuation, but do not pit on pressure. The skin remains soft and flexible as normal. There are no distinct evidences of muscular degeneration, but the patient becomes weak and indisposed to physical exertion. There is no disturbance of the psychic functions, but the mental processes are sluggish. The cutaneous sensibility may be slightly altered, areas of anesthesia, or particularly of hypesthesia, being found in various parts of the body. The knee-jerks are usually lost, but Romberg's symptom is not present. Death occurs as a result of some intercurrent affection.

The **differential diagnosis** is to be made from simple obesity and from myxedema. From simple obesity it differs by the fact that the fat is firmer; it is irregularly distributed; nodules appear and disappear in the skin; and particularly by the sharp pains in the fatty masses. From myxedema, by the absence of mental changes, and of tetany, and by the presence of the pains in the fatty masses. The distinguishing test is the failure to respond to thyroid medication. (See also pp. 1132 and 1192.)

The **prognosis** is hopeless for cure, but the duration of the disease is often greatly prolonged. Dercum's original case was under observation for eleven years, and then died of fatty degeneration of the heart.

Treatment is unavailing. The administration of thyroid substance appears to be of no benefit. The pains must be controlled with anodynes, employing at first the coal-tar analgesics, particularly phenacetin, which must be used in small doses on account of the chronic nature of the case, and if this is insufficient, morphin must be administered.

AMAUROTIC FAMILY IDIOCY

Tay and Sachs have described, independently, a most extraordinary disease of the central nervous system which is characterized by the occurrence, a few months or a few years after birth, of marked impairment of intelligence, and gradually progressive loss of vision. The pathology of the disease is not known. Degeneration of the cells, perivascular accumulation of round cells, and some degeneration of the fibers in the central nervous system have been found. The etiology of the disease is not understood. It is usually hereditary or familial, that is to say, several children in one family are sure to be affected. As it occurs in early life direct inheritance is, of course, impossible, but children of the ancestors have sometimes suffered from the same condition. It is also racial; all the cases hitherto recorded, with one doubtful exception, having occurred among Jews.

The **symptomatology** is as follows. The child at first develops normally, appears healthy and intelligent. Usually in the latter portion of the first year or in the early part of the second, its mother observes that it does not notice as well as formerly; that it appears to be weaker and less intelligent. It gradually becomes more and more idiotic until it is a complete imbecile, uncleanly in its habits, and at the same time the blindness progressively increases. This blindness appears to be due to a degeneration of the retina, the earliest sign being a bluish discoloration or spot in the region of the macula. The reflexes are usually greatly increased and sensation becomes generally blunted.

The **differential diagnosis** is to be made from other forms of idiocy occurring early in life. The race, the familial type of the disease, and particularly the progressive blindness, with the peculiar changes in the eye-ground, usually suffice to determine the character of the disease. (See also p. 1108.)

The **prognosis** is hopeless. The children die in the course of from three to five years.

Treatment is of no avail. Prophylaxis has been attempted, particularly by keeping the mother in good condition before and during pregnancy, and by careful attention to the health of the child during early infancy. As only a certain number of children in each family are affected, it is impossible to determine how effective these measures are. They should at least be employed in all cases in which one member of the family has had the disease. Antisyphilitic remedies are injurious.

VII. VASOMOTOR AND TROPHIC DISORDERS

ANGIONEUROTIC EDEMA

(*Acute Circumscribed Edema of the Skin; Intermittent Angioneurotic Edema; Giant Urticaria*)

Definition.—A disease characterized by the appearance of an edematous swelling of the skin or mucous membranes. In general, it is not accompanied by constitutional symptoms.

The **pathology** of the disease is obscure. It is supposed to be due either to venous stasis or to some nervous influence upon the lymph-channels, causing them to exude liquid. No lesions have as yet been described. It is a vasomotor neurosis.

Etiology.—Neuropathic heredity appears to have some influence upon the disease, but nervous manifestations in the patient himself are more important. Occasionally the condition follows infectious diseases or severe hemorrhage. The most important exciting causes are cold and emotional disturbances. The disease occurs most frequently in males, and almost exclusively in early adult life. (See also p. 1069.)

Symptoms.—The *edema* usually appears suddenly, is sharply circumscribed, and the skin of the affected area is slightly elevated and reddened, or else somewhat paler than the surrounding tissue. It does not pit on pressure. Ordinarily, subjective symptoms are absent; occasionally there are slight *paresthesiæ*. The edema may appear in any part of the body, but usually it is most common on the backs of the hands or legs and in the face, especially the eyelid. Occasionally it may appear upon the mucous membranes either of the lips, tongue, or glottis; in the latter situation it sometimes produces severe dyspnea, and at least in one case it has caused death. Its presence has also been suspected in the mucous membrane of the gastro-intestinal tract. Ordinarily the patient has no symptoms whatever of disease; occasionally, however, there are severe colicky pains and sometimes vomiting. In one case hematuria was observed, and in another hemorrhage from the swollen gums; of course, in the latter case the diagnosis was doubtful. Certain writers have noted eosinophilia, with or without leukocytosis. The patient may exhibit a certain degree of anxiety during the attack. Ordinarily the swelling persists a few days, and then disappears, but relapses are exceedingly common, and may recur very frequently for many years.

The **differential diagnosis** has to be made from urticaria, to which it bears a great similarity. According to Osler, giant urticaria is the same disease.

The **prognosis** is, of course, favorable for life unless edema of the glottis occurs; for cure it is more doubtful, as the disease is sometimes exceedingly obstinate.

The **treatment** consists of rest, the use of tonics particularly directed to the nervous system, and the correction of any gastro-intestinal disorder. Strychnin has proved very valuable. Atropin during the attack is also of service. If the larynx is affected, scarification of the edematous areas and even tracheotomy may be required.

RAYNAUD'S DISEASE

(Symmetric Gangrene)

Definition.—A condition apparently of vasomotor nature, affecting symmetric parts of the body, and chiefly the tips of the extremities.

Pathology.—Clinical and pathologic studies seem to show that this condition, as well as others to be mentioned under diagnosis and which are closely related, are dependent upon disease of the peripheral blood-vessels, causing deficiency of the blood-supply. This may be a vasomotor spasm or some form of endarteritis. They may also be associated with organic disease of the spinal cord, especially tabes dorsalis and peripheral neuritis.

The **etiology** of the condition is obscure and complex, largely, no doubt, because a number of different conditions have been confounded under this designation. The disease occurs in children and in neurotic women, less often in men. A neuropathic heredity seems to predispose to it, and occasionally it exists in connection with other nervous diseases, as epilepsy, migraine, hysteria, and mental disorders. The occurrence of paroxysmal hemoglobinuria has led to the suspicion that malaria is an etiologic factor. I am not aware, however, that plasmodia have been found in any case, and the asserted good results following the administration of quinin are insufficient to establish the contention. Syphilis and various other infectious diseases have also been mentioned as etiologic factors. The most important exciting cause is exposure to cold, although attacks may also be brought on by severe emotional disturbances.

Symptoms.—The attacks at first are paroxysmal, a typical one consisting of: first, anemia or local syncope; second, cyanosis or local asphyxia; and third, either local hyperemia or, if this does not occur and asphyxia continue, local gangrene. *Local syncope* consists in a vasomotor spasm in one or more extremities, the fingers being most frequently affected, and rarely more than one at a time. They become white, almost waxy in appearance, cold, and hard to the touch, and they may be either dry or covered with a cold perspiration. The finger is perfectly numb, but severe neuralgic pains may be felt in the arm; if the skin be pricked with a pin, no blood flows. Ordinarily this syncope disappears gradually, the reaction being accompanied by tingling and formication in the affected digit, which ultimately returns to a normal condition. *Local asphyxia* is a further stage of this condition: in this the finger is blue and swollen, and there is a sense of discomfort that is apparently due to the stretching produced by the engorged veins. The cyanotic condition may also affect the ears, toes, and the tip of the nose, and, like the preceding stage, it may disappear without leaving any trace of its existence. Patients that have reached this stage seem to be more liable to a recurrence upon slight exposure than those who only present local syncope. The attacks are more likely to recur constantly in the same digit, and not to appear first in one and then in another. During the existence of this stage a not infrequent associated symptom is *hemoglobinuria*; this is especially apt to occur in children, and has led to the suspicion of malarial influence. In some cases, when hemoglobinuria is not found, the urine contains an excess of urates. If hyperemia occurs the affected parts become bright red, which finally disappears and the normal appearance develops. If the attack lasts for several days, *trophic changes* take place in the finger-nail, giving rise to a transverse ridge, which persists until that portion of the nail has grown beyond the end of the finger. If local cyanosis, however, continues sufficiently long, *gangrenous* changes take place. These appear first as small black spots or vesicles filled with serum upon the end of the fingers or about the root of the nail; these gradually slough off, leaving a small ulcer that may slowly cicatrize. Often patients subject to recurrences of the

disease show a number of cicatrices on the ends of the fingers, or if the ears are affected there may be slight shriveling of their edges. The gangrene, however, may be more severe, in which case the distal phalanges of the affected fingers may become black or dark red, covered with blebs, and finally mummified. The line of demarcation then forms, and ultimately the gangrenous portion falls off, leaving an ulcerated stump that slowly cicatrizes. This form may not be limited exclusively to the hands and feet or ears, but symmetric patches sometimes appear in the skin of the breast. During the time that the gangrene is present the patients suffer from excruciating *pains* in the limbs that interfere with sleep, often causing transient melancholia, and seeming, more than the gangrene itself, to depress the general condition. Fever is rarely present; sugar is sometimes found in the urine, but not constantly.

Diagnosis must be made from erythromelalgia; acroparesthesia (p. 1200); acrocyanosis, in which condition we have cyanosis of the extremities, often associated with gangrene and ulceration, but which differs from Raynaud's disease in not being paroxysmal; and intermittent claudication, which is characterized by muscular cramps, numbness, and transient loss of motor power dependent upon exertion (p. 1106). As has been said, all of these symptom groups are closely related, and a sharp line of demarcation cannot always be maintained. The condition of the posterior tibial and dorsalis pedis arteries should always be determined, an absent or diminished pulsation being frequently found. Cases of this type are especially prevalent among the Russian Jews, and the feet are mostly affected. They are characterized by more or less constant pain, constant coldness of the feet with local syncope, tenderness of the calves, diminution of sensibility in the feet, followed by local asphyxia and gangrene. The pain is usually relieved by allowing the feet to hang down. Buerger has applied the name thrombo-angiitis obliterans to them. Diabetic gangrene with neuritis may be confounded, but examination of the urine should make the diagnosis clear.

Meyer,¹ however, claims that there is no true obliterative thrombosis of the blood-vessels, but rather a conglomeration of red cells in the vessels due to erythrocytosis and stasis. Associated with this there is marked viscosity of the blood and regularly an intolerance for carbohydrates. On account of this factor he suggests the name of *glycophilia* for the disorder.

Senile gangrene differs in its mode of onset and by its occurring in old age. Tabes dorsalis, in which these symptoms may occur, can be distinguished by the occurrence of other characteristic symptoms of that disease. The same may be said of syringomyelia. Peripheral neuritis may be sometimes difficult to exclude, especially the form known as senile neuritis, due to arteriosclerosis. If tenderness over the nerve-trunks and muscular weakness and atrophy are present, neuritis undoubtedly exists.

Leprosy may also have to be considered. Scleroderma (p. 1202) is also related to the vasomotor neuroses above mentioned, and may be mistaken for them.

The **prognosis** is favorable unless there is some arterial disease. Ordinarily they become in time less frequent and ultimately disappear, but in a few cases the tendency to recurrence is obstinate.

The **treatment** consists of improvement in the general condition during the intervals. During the attack the most effectual measures are a mild massage, the use of local lukewarm baths, and electricity very cautiously applied either by the application of the anode to the spine and the cathode placed in a vessel containing water into which the affected part is put or the high-frequency current. Nitroglycerin is sometimes beneficial. For the relief of the local syncope Cushing has devised a plan of treatment which has been

¹ *Jour. Amer. Med. Assoc.*, 1918, lxxi, 1268.

successful. It consists in applying an elastic bandage to the limb tight enough to stop the arterial circulation for several minutes; it is then loosened, when the circulation will usually return. In obstinate cases it may have to be repeated. Pilocarpin also has been employed with good results. If the pains are very severe, they must be combated by morphin—although gangrene may occur at the site of the injection—administered hypodermically, if necessary. Sleep should be obtained by means of narcotics. The gangrenous parts should always be carefully protected by a local dressing, and surgical intervention in the form of amputation may be required. If so, it must be done high or a return of symptoms may occur.

ERYTHROMELALGIA (*Weir Mitchell*)

(*Paralytic Vasomotor Neurosis of the Extremities*)

Definition.—A disease characterized by paresthesia, redness of the skin, and by pain, usually in the toes and heels, associated with more or less severe general disturbances.

The **pathology** is doubtful—arteriosclerosis of the blood-vessels in the affected limb has been found, but the disease appears to be due to some disturbance of the vasomotor centers or nerves.

Etiology.—It may occur in association with various forms of spinal cord disease (see Raynaud's Disease).

Symptoms.—The earliest symptom, as a rule, is the occurrence of severe *pains in the feet*. Objectively, there are swelling and reddening of the skin, and the sensitiveness is so severe that the patient is unable to walk. The attacks occur more frequently during the summer months, and are always aggravated by exposure to heat or a vertical position of the limbs. Ulceration may occur.

The **diagnosis** is often difficult, the condition being confused with inflammation of the foot. Operations have frequently been performed upon these cases. A characteristic feature of the condition is that the redness and pain are excited by allowing the feet to hang down, and disappear when they are elevated (see also Raynaud's Disease). It may occur in the course of hemiplegia and in some organic diseases of the spine, and these should be excluded.

The **prognosis** as to relief is bad; often the disease will recur at irregular periods for a number of years. The attack can usually be cut short by plunging the limb into ice-cold water.

Treatment.—This should always be tonic, and employed during the intervals; massage, hot and cold douches, and the faradic current may be used upon the affected extremities. The pain may call for anodynes. Resection of the long saphenous and musculocutaneous nerves and stretching of the plantar nerves have been done with success. It has also caused gangrene.

ACROPARESTHESIA

(*Spastic Vasomotor Neurosis of the Extremities; Waking Numbness*)

Definition.—A disease characterized by abnormal sensations in the hands, slight vasomotor disturbances, and slight stiffness of the fingers.

The **pathology** and **etiology** are not understood. Those of a neurotic temperament are more liable. It is also in some cases associated with the

gouty diathesis or other metabolic disturbances. It is probably a neurosis, although in some cases there may be a neuritis. It occasionally occurs after injury or as a result of prolonged exposure to cold, hence is common among laundresses. It is more frequent among women than men, and usually develops in middle life.

The **symptoms** consist in the more or less sudden development of *formication* and *tingling* or *numbness* in the fingers and finger-tips, usually bilateral, but sometimes occurring only on one side. Less frequently the toes are affected. These pains are more severe in the night and early morning, frequently arousing the patient from sleep. The vasomotor disturbances are variable. Sometimes nothing can be observed, and sometimes the extremities are bluish^o and cold, sometimes pink and warm. Sensibility is rarely affected. In some cases, however, there is considerable hyperesthesia; in others moderate anesthesia. In a few cases there is stiffness of the hands. Slight *trophic disturbances* have been reported in a few cases. The attacks may last from a few minutes to several hours, and may recur frequently or only at considerable intervals. Usually during the attack the abnormal sensations are continuous, but occasionally they are intermittent in character. The condition known as *tender toes*, that occasionally occurs after an attack of typhoid fever, is probably a form of this disease. It is ascribed to the Brand treatment, but incorrectly.

The **diagnosis** is usually easy. Care should be taken, however, not to confuse these cases with commencing locomotor ataxia, subacute combined sclerosis, tetany, or hysteria. In Raynaud's disease cold increases the intensity of the symptoms.

The **prognosis** is, in general, favorable, the disease usually disappearing after some months; sometimes, however, the condition is obstinate.

The **treatment** is rather unsatisfactory. Laundresses should be advised to adopt some other vocation. Local stimulation with the faradic brush has sometimes been of value, and hydrotherapy, to exercise the vasomotor system, may also be employed. At the same time the patient should be given tonics, particularly if anemia is present, or eliminative treatment if indicated. Salicylates seem to be of service in some cases. Large doses of quinin at bedtime are sometimes useful, as is also the causing of congestion in the fingers by constriction of the arm for two or three minutes three times daily with an elastic band or Esmarch bandage. Alkaline washes are almost a specific for the tender toes. Saturated solutions of sodium bicarbonate should be employed.

MERALGIA PARÆSTHETICA

(Bernhardt's Disturbance of Sensation)

Definition.—A disease characterized by paresthesia and disturbance of sensation on the outer side of the thigh, in the region supplied by the external cutaneous nerve.

Pathology.—Nawretsky has examined one case, and found chronic interstitial neuritis. There is reason to believe that this is not always present.

Etiology.—This is very various; some of the cases have been preceded by injury, excessive exercise, or infectious disease. Alcoholism, constipation, and pregnancy are also common predisposing causes; cold douches have been blamed in several instances. Sometimes the disease is hereditary. The exposed situation of the nerve to pressure is supposed to render it more liable to this peculiar disturbance.

Symptoms.—These are of two varieties: First, the *paresthesiæ*. There may be burning, tingling, or stabbing pains that are severe enough to disable

the patient; or there may be only a feeling of cold or numbness. Second, the *sensory disturbances*. These vary from slight hyperesthesia to total anesthesia. The different senses are not always equally involved; pain, temperature, and electrocutaneous sensibility being usually more profoundly affected than the others. Frequently both thighs are affected. There is often a tender point just inside the anterior superior spine of the ilium.

The **diagnosis** is easy.

The **prognosis** is doubtful. Some of the cases recover rapidly, but the majority become chronic.

Treatment.—But little can be done. Locally, the dry brush seems to do good in some cases; the high frequency current is worth a trial. The general health should be improved if possible. In aggravated cases a portion of the nerve may be excised.

SCLERODERMA DIFFUSUM

Definition.—A peculiar hardening of the skin, with areas of pigmentation and depigmentation, associated in the more advanced stages with trophic lesions, muscular atrophies, and affections of the bones.

Pathology.—The affected skin is characterized by an increase of the connective tissue and of the elastic fibers, and by a narrowing of the vessels as a result of perivascular infiltration.

The **etiology** is not clear. Some of the cases are associated with joint affections that resemble those of chronic rheumatism; others follow exposure to a very low temperature. The presence of trophic lesions in the skin and the development of myopathies lead to the supposition that it is properly classed with the trophoneuroses. The disease usually occurs in middle life, although cases have been observed among children. Women are more frequently affected than men.

Symptoms.—Three stages are recognized: *First*, a rather dense edema. *Second*, a true sclerosis, in which the skin appears thicker, with an absence of the normal folds; it becomes firm and hard, so that it cannot be pinched between the fingers and lifted from the flesh. Moreover, there are always *pigmentary changes*, certain parts being darker than normal, while others become a dead white, appearing almost as if composed of alabaster. The disease, as a rule, attacks first the upper portion of the body—*i. e.*, the face, neck, hands, and arms, or the surface of the thorax—and is most pronounced in those regions where the bones are subcutaneous. The *diminished elasticity* considerably interferes with the movements of the body. If the neck is affected, it is difficult to turn the head; if the skin over the joints is involved, their normal flexion and extension cannot be perfectly performed. The subjective sensations are those of tension, the patient complaining that the skin has become “too small” for him. If any forcible action is attempted, there is severe pain, accompanied by slight tears in the skin. The skin is paler and cooler than normal, and the slightest exposure to cold causes great discomfort and cyanosis. The secretion of sweat may be normal, but is usually diminished. Tactile sensibility is unimpaired. The *third stage* is that of atrophy; the skin becomes thin as paper; the other symptoms, however, remain as before, except that the secretion of sweat is abolished and *ulcerations* appear that either heal slowly or not at all. In addition, there are muscular atrophies associated with contractures. Often there is considerable *atrophy of the bones*, or there may be a development of exostoses from the periosteum (sclerodactylia). Occasionally

the end-phalanges of the fingers undergo a process of gangrene that is similar, in some respects, to that of Raynaud's disease. *Chronic joint affections* may also be observed in this stage, particularly of the fingers (see Morphea).

The **course** of the disease is variable. Usually it develops slowly and lasts for many years.

The **diagnosis** is usually easy, though occasionally it has been confused with *Addison's disease* on account of the excessive pigmentation. There is, of course, some resemblance to *Raynaud's disease*, although the condition of the skin itself is very different. In the atrophic stages it may be confounded with xeroderma pigmentosum.

The **prognosis** is always doubtful. In the later stages the patients become emaciated, and pass into a cachectic state, in which death may occur. Pulmonary complications may develop. Complete cure may, however, occur, and particularly in cases that have a rapid course.

The **treatment** is unsatisfactory. The unpleasant tension of the skin may be somewhat diminished by ointments and massage; warm water or steam baths may also give considerable relief. The most important thing is to maintain the general condition of the patient by tonics and a change of climate. Sodium salicylate has been recommended, but is probably valueless. Thiosinamin hypodermically may prove to be of service.

MORPHEA

(*Scleroderma Circumscriptum*)

This disease consists of the development of *small areas of sclerosis* of the skin that are distinctly related to the distribution of the nerves. These areas are round or oval, brownish or violet in color, and as they increase in size there develops in their centers more or less sclerosis. In these sclerotic areas there are often punctiform collections of pigment, the hairs fall out, and superficial ulcerations may be present. Occasionally they may go on to atrophy of the skin. There are no constitutional symptoms.

The **diagnosis** is usually easy.

The **prognosis** as regards life is favorable; as regards cure it is doubtful.

The local **treatment** is the same as for the diffuse form of scleroderma.

AINHUM

This is a disease characterized by an enlargement of the little toe and the formation of a line of demarcation at its base.

The **pathology** is not known, but it appears from a roentgen-ray picture that the bones are absorbed. There is some dispute as to whether it is one of the manifestations of leprosy or not. At any rate, it does not appear that typical lepra bacilli have been found.

Etiology.—The disease may occur in childhood or early adult life, and is most common in negroes. It occurs almost exclusively in tropical regions—*e. g.*, Brazil and Syria.

The **symptoms** of the condition consist in the formation of a *furrow* at the base of the little toe of one of the feet. This grows deeper and deeper until spontaneous amputation has occurred. Rarely the other toes on the same foot become progressively involved. Certain *vasomotor disturbances* may be ob-

served; the foot is usually swollen, bluish red, and cold; sometimes the other foot may exhibit similar changes without the formation of furrows at the base of the toes. There is some *diminution of sensation* to touch, temperature, and electricity, and ordinarily the patient complains of vague pains in the limbs.

The **diagnosis** is to be made from leprosy, with which, indeed, it may be identical, and congenital amputation; the latter only occasions difficulty when the disease commences in early life.

The **prognosis** is favorable to life, but the disease is usually slowly progressive.

No effective **treatment** has been discovered but the parts should be protected against injury, and the patients may be given tonics and anodynes as required.

PROGRESSIVE HEMIATROPHY OF THE FACE

(*Progressive Facial Atrophy*)

Definition.—A rare disease, characterized, as its name would indicate, by a progressive atrophy of one-half of the face, stopping sharply at the middle line, and in the severer forms involving the skin, muscles, and bones.

The **pathology** of the condition is unknown. Rarely symptoms indicating irritation of the cervical sympathetic, such as dilatation of the pupil or flushing, have been present, and symptoms indicating inflammation of the trigeminus have been equally infrequent. Mendel, however, has reported a case in which he found chronic interstitial neuritis of the branches of the trifacial, and other cases have been reported in which the gasserian ganglion was diseased. Microscopic examination has shown a disappearance of the subcutaneous fatty tissue and a general atrophy of the elements of the skin itself, often associated with the presence of an abnormal quantity of pigment. As a rule, the vessels are relatively enlarged.

The **etiology** is unknown. The condition usually commences early in life and shows no predilection for either sex. An hereditary tendency does not appear to exist, but the disease occurs frequently as a complication of, or rather in connection with, other neurotic conditions. Of these the most frequent are neuralgia, migraine, epilepsy, and mental disorders; less frequently, tic convulsif and chorea, particularly if the latter affects the muscles of the jaw and tongue. Occasionally it has been recorded as occurring in patients suffering from syringomyelia, locomotor ataxia, or multiple sclerosis. It does not appear, however, that progressive facial atrophy has any anatomic connection with these conditions. In a few cases the disease has been preceded by an injury to the skull or face, and in others it has followed an acute infectious disease. Ordinarily it occurs in early life—*i. e.*, between the tenth and fifteenth years—and in these cases it usually progresses to the most severe type.

The earliest **symptom** is a flattening of the skin on the affected side, constituting the lightest form of the disease, which may remain stationary at this point; if, however, it progresses, the muscles and bones also become involved, so that the affected half of the face is distinctly smaller than the healthy side. The objective changes that take place in the skin are the development of *white spots* in which the pigment has disappeared, and which have the appearance almost of scar-tissue, or, what is more commonly the case, of an increase in *pigmentation* with a formation of yellowish or brownish blotches, the skin being depressed in these areas, which usually lie along the course of the nerve-trunks, especially the infraorbital. The *hair* becomes thinner, dryer, and often falls out. The secretion of the sebaceous glands is diminished and the skin dryer.

Rarer phenomena are the *disturbance of blushing*, so that the affected side of the face remains unchanged in color when, as a result of some emotional disturbance, the other is distinctly reddened. Disturbances of sensation are not common. In some cases electric and tactile sensibility have been diminished; in others the patients have complained of slight paresthesiæ. The special senses remain unaffected, and even when the atrophy extends to the tongue, taste remains perfect on the affected side. In one case there were a slight disturbance of hearing and occasional tinnitus.

The **diagnosis** of the condition is easy both when it is suspected and when it is far advanced. The only condition with which it could be confounded is congenital facial asymmetry. In facial hemiatrophy, however, the skin is shrunken and wrinkled, and the hair is dryer and thinner, contrasting markedly with the healthy side, and there is usually a history of commencement some years after birth. In congenital asymmetry the difference between the two sides is slight, and the skin over the smaller side is normal in every respect. Commonly in this condition we also find differences in the development of the extremities. In a case that I recently observed with marked facial asymmetry, the left side being smaller, the hand and foot on the same side were distinctly smaller than the corresponding members.

The **prognosis** is unfavorable as regards cure. The disease itself is not in the least dangerous, and cases have been recorded that have been under observation for thirty years or more.

Treatment is unsatisfactory. The prolonged use of electricity has been said to arrest the process, and sometimes this arrest occurs spontaneously; it is not certain that the treatment is of any use.

An allied condition is **hemihypertrophy of the face**. This is an exceedingly rare condition, and is apparently always congenital. It involves chiefly the soft parts, the ear, skin, tongue, and tonsils being all enlarged. There is an increased secretion from the sebaceous glands, which may appear as small elevations upon the skin. Usually, as in congenital asymmetry, there is enlargement of the extremities on the same side. The only case that has come to autopsy presented no lesions.

Treatment is, of course, unavailing.

PART XI

DISEASES OF THE MUSCLES

MYOSITIS

RHEUMATIC myositis and the suppurative form observed in pyemia, and rarely in other acute infectious diseases, have been appropriately described in connection with the diseases to which they are secondary manifestations. There remain to be discussed two rare forms of the disorder.

INFECTIOUS MYOSITIS (*Acute Polymyositis*)

Definition.—A primary acute or a subacute inflammation of the voluntary muscles due to an unknown microbic agent.

Pathology.—The disease is a true inflammation of all the voluntary muscles, involving chiefly the muscular fibers, and to some extent, also, the interstitial connective tissue. Beginning with marked hyperemia, there next occurs an exudation of leukocytes. The muscles are hard, fragile, and later undergo fatty degeneration. Serous infiltration occurs and there is a slight hyperplasia of the intermuscular connective tissues. Hueppe records a case that showed nothing definite beyond a hyaline degeneration of the muscular fasciculi.

Etiology.—We are no less ignorant of the predisposing influences than of the specific exciting agency, though, perhaps, young males are most often the victims of this malady.

Symptoms.—As a rule, first the muscles of the extremities, and later of the trunk also, become swollen, firmer than normally, and stiff, rendering locomotion somewhat difficult and painful.

The involved parts may also be tender to the pressing finger, and a slight edema may be noticed that is at first more or less localized, but finally becomes generalized, and extends even to the face. An erythematous eruption then appears, which is irregularly disseminated over the skin surface, and may tend to more or less pigmentation. Moderate pyrexia and splenic enlargement are among the early and constant symptoms. In the advanced stage the muscles of deglutition and of respiration become involved, rendering the act of swallowing difficult, and inducing marked dyspnea.

Among the *complications* may be enumerated bronchitis and bronchopneumonia, the latter often being a terminal condition.

Diagnosis.—Taken in the aggregate, the symptoms are of little diagnostic importance and the previous history is invariably negative. *Trichiniasis* must be discriminated, since this disease produces an identical clinical picture. The distinction may rest upon the examination of an excised piece of affected muscle, which will not only discover the trichinae, if present, but also enable the microscopist to detect the positive evidences of polymyositis. *Multiple neuritis* presents neither swelling nor edema.

Course and Prognosis.—The course of the disease may either be comparatively rapid (two or three months), or it may be slow (chronic) and continue over two or three years. It usually terminates in death, which is

caused, in the immense majority of cases, by paralysis of respiration. Occasionally, since the heart muscle has been sometimes found to be implicated, the end may be preceded by cardiac failure.

The **treatment** is simply palliative and supportive.

PROGRESSIVE OSSIFYING MYOSITIS

Definition.—Myositis, either general or local, in which the affected muscles undergo progressive ossification.

Pathology.—Following the changes that ordinarily characterize myositis (swelling, leukocytic exudation, etc.), a calcification that is often complete takes place. The process may extend to and involve the heart.

The **etiology** is obscure, though males are especially the subjects of the complaint, which usually begins about the time of puberty.

Diagnosis.—The muscles are represented by plates of bony hardness, leading to more or less complete ankylosis of the joints and vertebræ.

The **course** of myositis ossificans is very slow, and **treatment** has afforded only negative results.

MUSCULAR DYSTROPHIES

Definition.—These are hereditary affections characterized by progressive muscular wasting beginning in certain groups of muscles, which is sometimes preceded by or associated with apparent hypertrophy of other muscles, without fibrillary tremors and marked change in the electric reactions. They are also known as myopathies.

Etiology.—The only factor known is the influence of heredity, the disease running through a number of generations. It usually appears before puberty, but may develop later.

Morbid Anatomy and Pathogenesis.—In the early stages true hypertrophy of muscle-fibers may be found. Later, proliferation of the muscle nuclei and longitudinal splitting of the fibers, with an increase of connective tissue which takes the place of the degenerated muscle-fibers. A marked deposit of fat is present in the pseudohypertrophic type. The nervous system is normal. McCrudden¹ states that among the causes of muscular dystrophy is a hypoglycemia, depending on impaired glycogenesis, the carbohydrates being changed largely into fat instead of glycogen, and that this is due to disease of the adrenals and other endocrine glands. Janney, Goodhart, and Isaacson² found affection of the pituitary in 1 case.

Symptoms.—A number of clinical types have been described, depending upon the muscles first affected, occurrence or not of apparent muscular hypertrophy, and the age of onset. They may all more or less overlap. They are:

1. Pseudomuscular hypertrophy of Duchenne.

- (a) Leyden-Moebius or hereditary type.

2. Erb's juvenile or scapulohumeral type.

3. Landouzy-Déjérine type, or infantile progressive muscular atrophy of Duchenne or the facioscapulohumeral type.

Cases in which the symptoms were unilateral have been described, and also in which the atrophy was limited to the periscapular muscles.

PSEUDOHYPERTROPHIC MUSCULAR PARALYSIS

Symptoms.—This form usually appears under the age of ten. The enlargement, as a rule, affects the muscles of the calves of the legs, although

¹ *Jour. Amer. Med. Assoc.*, April 27, 1918, p. 1216.

² *Archives Int. Med.*, February, 1918, p. 188.

various muscles in other parts of the body may be involved, as the infraspinatus and masseter, or the muscles of the arms and thighs, giving the patient the appearance of an unequally developed athlete. With this may be associated atrophy of the latissimus dorsi, lower part of the pectorals, and muscles of the upper arm and thigh. The electric reactions show no qualitative alteration, but are quantitatively diminished in proportion to the loss of power. This loss of power is manifested first in the gait, which is uncertain and waddling; next, by the difficulty the patient has in arising from the ground. He first gets on his hands and knees, then lifts his knees from the floor and, placing his hands first on his ankles, climbs up his legs until he assumes a more or less upright position (Fig. 79). In the later stages of the disease the volume of the muscles becomes less than normal. At this period contractures may occur leading to the development of club-foot or of lateral deviation of the spine. Lordosis may also be produced by weakness of the muscles of the back, and the spinal column, being no longer properly supported, may topple to one side or the other. Ultimately the patient may lose all power in the affected limbs and pass into a cachectic state, in which he dies. Few ever reach adult life. Some of the cases, however, seem to be milder in character, and may amount to nothing more than a slight weakness, which persists throughout life, but does not seriously inconvenience the patient. Often signs of intellectual disturbance are present, the patient learning more slowly and showing an impaired intellectual co-ordination. At other times epilepsy may be present. A peculiar



Fig. 79.—Mode of rising from the ground in pseudohypertrophic paralysis (Gowers).

variety is known by the French as *forme fruste*; this is characterized by a rapid atrophy of the hypertrophied muscles, and consequently the course of the disease is more severe.

HEREDITARY MUSCULAR PARALYSIS (*Leyden-Moebius*)

This commences in children, and usually between eight and ten years of age. It affects the muscles very much as they are affected in the pseudohypertrophic form, except that there is no increase in size. The disease is markedly hereditary in type.

SCAPULOHUMERAL OR JUVENILE TYPE (*Erb*)

Symptoms.—This type may appear as late as twenty years of age. The muscles first affected are usually the pectorals and the latissimus dorsi. From these the process rapidly extends to the muscles in the neighborhood—*i. e.*, the serrati and the muscles of the back. The muscles of the upper arm and thigh are usually most involved. Those that are most likely to escape are the sternomastoid, the spinati, deltoid, and those of the forearm and leg below the knee. The extensors of the wrist and fingers and the tibialis anticus and peroneal group may, however, eventually become affected. The muscles gradually waste, and the wasting is accompanied by a corresponding loss of power, a diminution in the reflexes, and of the electric reactions. Reactions of degeneration are not present. Certain peculiar appearances are produced by

the atrophy of certain of the groups of muscles. As the shoulder-blades are no longer supported, they stand out from the back, giving rise to the so-called "winged" appearance, and as the result of the weakness of the muscles of the back lordosis is exceedingly common. Weakness of the muscles of the back, and particularly of the glutei, causes the patient, when he rises from the stooping posture, to go through the same actions that are carried out by children suffering from pseudomuscular hypertrophy—*i. e.*, climbing up his own legs. Motion is affected proportionately with the degree of atrophy. The gait is disturbed and becomes waddling, due to the alternate lifting of the sides of the pelvis in order to clear the foot of the ground. Sensation is never disturbed. The sphincters are not involved and bulbar symptoms do not appear, even late in the disease.

FACIOSCAPULOHUMERAL TYPE (*Déjérine-Landouzy*)

Symptoms.—This type usually develops about the third or fourth year. The disease usually begins in the muscles of the face. Of these, the muscles about the angle of the mouth first undergo degeneration, giving rise to a peculiar expression, caused by the lips protruding (tapir mouth); the under lip drops forward and downward; the upper lip is wasted and expressionless; all wrinkles disappear, and the patient has a peculiar and strikingly stupid expression. The ordinary movements of the face are considerably affected. Whistling cannot be accomplished and speech is imperfect. Otherwise the course of the disease is that of the scapulohumeral type.

The **diagnosis** is to be made from the *spinal* and *neural forms* of muscular atrophy and from the *congenital absence* of certain groups of muscles. From the two first-mentioned forms it can readily be distinguished by the fact that the hand becomes involved, if at all, in the last stages of the disease; also by the absence of the reactions of degeneration and of muscular twitching. It is also diagnosed from the neural type by the absence of disturbances of sensation. From the congenital absence of certain groups of muscles the diagnosis is sometimes difficult, for, curiously enough, the groups of muscles affected are usually the same as those affected by the myopathy. A distinction can be made partly by the history, partly by the more efficient and perfect compensatory hypertrophy of the muscles that remain.

The **course** of the disease is slowly progressive, only occasionally exhibiting a temporary arrest.

The **duration** is variable, but patients may live thirty or forty years after the first symptoms appear.

The **prognosis** is, of course, hopeless as regards cure or improvement. As regards existence, however, it is the most favorable of all the forms of progressive muscular atrophy—a fact that is probably due to the ability of the patients to walk until the very last stages of the disease, so that they are able to maintain a better physical condition.

The **treatment** is the same as that for other forms, and consists of electricity, massage, and especially of systematic gymnastics. The administration of adrenal or other endocrine gland should be considered (p. 1207). Children born of dystrophic parents should be guarded carefully, their nutrition being maintained at the highest possible point and physical strain avoided. Mothers so affected should not suckle their children.

MYOTONIA ATROPHICA

This rare condition is characterized by weakness and atrophy of the facial muscles resembling that found in the facioscapulohumeral type of dystrophy. The sternomastoids, vasti of the thighs, and dorsal flexors of the feet are also

usually affected, as may also other muscles. With this there is a slow relaxation of certain muscles after contraction, the stronger the contraction the slower being the relaxation. In some instances cataract developing early in life has been a symptom. It may be a familial disease.

ARTHRITIC MUSCULAR ATROPHY

Pathology.—It has frequently been observed that after inflammation of a joint the muscles that move it have undergone a certain degree of atrophy. This usually occurs in the extensors, and is severe in proportion to the duration of the inflammation. Microscopic examination of the muscles shows a rather uniform diminution in the breadth of the fibers, as well as a slight proliferation of the nuclei and occasionally an indistinctness of the striation. The nerve-trunks and cord have been reported to be normal.

The **etiology** of the condition is not clearly determined. It has been supposed to be due to disuse, but if such were the case all the muscles moving the joint would be equally affected. Moreover, it sometimes occurs too rapidly to render this explanation acceptable. It has also been supposed to be due to the extension of the inflammation either to the nerves or directly to the muscles, but the other symptoms of neuritis are rarely present. Finally, Vulpian has suggested that it is of reflex origin, and this hypothesis is most generally accepted.

Symptoms.—The wasting usually occurs very rapidly after the onset of the joint affection. The muscles show a diminished contractility to faradism and galvanism, but the reactions of degeneration do not occur. Occasionally there is fibrillary twitching. The mechanical irritability of the muscles is greatly increased, and the reflexes show a corresponding exaggeration, ankle-clonus being frequently observed when the knee- or ankle-joints are affected.

The **diagnosis** may be readily made upon the existence of the joint affection, the local character of the muscular atrophy, and the absence of degenerative reactions with increased mechanical irritability.

Prognosis.—Ordinarily, as soon as the joint has recovered, improvement commences in the muscles and progresses rapidly to complete restoration of function. In some cases, however, atrophy persists, and in a few instances secondary contractures take place.

The **treatment** consists, first, in the removal of the cause by the cure of the articular condition; second, in gentle massage and electric stimulation of the muscles. As a rule this should not be commenced until the joint is well.

MUSCULAR ATROPHIES

These may also occur as a result of other conditions, such as direct injury, fracture of the bones, or prolonged work with a single group of muscles, but they scarcely demand separate description. On the other hand, *muscular hypertrophy* may occur, though rarely.

THOMSEN'S DISEASE

(*Myotonia Congenita*)

Definition.—An hereditary disease of the muscles in which the groups that have been contracted by a voluntary influence remain for a short time in a state of contraction, and then relax slowly.

Pathology.—Certain authors have described alterations in the terminal nerve-plates in the muscles, but it is difficult to determine whether these alterations are artificial or an actual part of the disease. The peripheral nerves are normal. The muscles themselves exhibit the following alterations: The muscle-fibers are, on the average, of an increased transverse diameter—*i. e.*, the smallest are the size of ordinary muscle-fibers, and the largest about twice the size. There is also a distinct and considerable increase in the number of nuclei. The protoplasm is not so clear as in normal muscles, but shows a fine granular cloudiness, rendering the striation less distinct. Occasionally the muscle-fibers are vacuolated. The connective tissue between the muscle-fibers is normal.

Etiology.—Hereditary influence is the most important factor in the causation of the disease. Thomsen, who was himself a victim, has been able to trace the disease for five generations in his own family. Occasionally a generation is skipped. Other factors that have been supposed to act as predisposing or exciting causes are prolonged exertion (a case having developed in a man without myotonic antecedents after two years of severe exertion) and emotional disturbance of the mother during pregnancy. Exposure to cold, and fright, and a neurotic temperament have also been accused of exerting a predisposing or exciting influence. The disease is somewhat more frequent in males than in females, usually develops in early life, is often associated with manifestations of mental disturbance, and occasionally occurs in those whose ancestors have exhibited lesions of the nervous system other than myotonia.

Symptoms.—The chief symptom of the disease is the so-called myotonic contraction. If the patient, after a period of rest, attempts to set a certain group of muscles in action, the first contraction is made, but is not followed by relaxation for a considerable interval—sometimes as much as half a minute; during this period the muscles remain in a state of tonic contraction. Thus, if the patient attempts to shake hands, he clasps the other hand strongly, and the clasp persists. When he lets go, it is seen that a slight degree of tonic contraction still exists, for it is impossible for him to straighten out his fingers immediately. Upon a repetition of the movement the tonic contraction recurs, but not so strongly, and if the repetition is continued, it disappears entirely, so that the muscular system of the patient behaves in all respects like that of a normal person, and long walks or other severe muscular exertion may be undertaken. In some cases practically the whole muscular system is affected, although, excepting the muscles of mastication, the muscles of the face usually escape. In others the disease is limited perhaps to the upper, perhaps to the lower, extremities. In the former condition the patient may, upon an attempt to make a vigorous motion after resting, suddenly become rigid and fall to the earth with considerable force, often injuring himself severely. He will then lie upon the ground perfectly conscious, but incapable of relaxing his muscles. When the disease, as is more frequently the case, is limited to the lower extremities, the chief disturbances observed are in walking. The first step is accomplished, whereupon the patient halts, both legs having become fixed; after a time they relax and another step is taken. The period of delay is now much shorter, and after a few more steps disappears entirely. The severity of the contraction is diminished by moderate exercise, heat, and tranquillity of the spirits, and is increased by excitement, cold, and fatigue. The muscles of deglutition and the sphincters and the muscles belonging to the non-striated muscular system are never involved. Pain is not present, except perhaps a slight sensation of cramp, nor are there disturbances of sensation. Mental disturbances are frequent, and have been ascribed to the anxiety occasioned the patient by the disease. They consist of irritability, the avoidance of society, and sometimes of melancholia. The reflexes show various modifica-

tions; the knee-jerks may be either normal, increased, diminished, or absent. The most important pathognomonic symptoms are the alterations in the electric reactions of the muscles. The changes are as follows: Mechanical irritability of the motor nerves is normal or diminished; but of the muscles it is increased, and so modified that the contraction instead of being sudden is slow, with a long tonic after-contraction. The faradic irritability of the nerves is normal, and faradic excitation of the muscles produces a tonic contraction of long duration. The galvanic irritability is quantitatively increased and qualitatively altered; that is to say, ACC is equal to and sometimes even greater than KCC. All the contractions are slow, tonic, and of long duration. Finally, the application of the constant galvanic stream gives rise to rhythmic contractions that pass along the body of the muscles in slowly moving waves at the rate of about one to three per second. Occasionally qualitative galvanic alterations have been observed in the nerves. Finally, the appearance of the patient is of some value. The muscles are developed almost as much as those of an athlete, without a corresponding increase of power.

The **diagnosis** is usually easy, and particularly if it be possible to examine the electric reactions. The condition might possibly be confounded with *pseudohypertrophic muscular paralysis*, in which the muscles are also considerably developed; but instead of being normal they manifest greatly diminished power and fail to give a myotonic reaction. From *tetany* the condition may be distinguished by the absence of Trousseau's sign, by a briefer period of tonic contracture, and an absence of severe pains. From *spastic paraplegia* and *Little's disease* it may be distinguished by the fact that in these diseases the spastic conditions are permanent and do not disappear after exercise. From *occupation-neuroses* it may be distinguished by the fact that the cramps only appear upon the performance of a certain peculiarly co-ordinated movement. From *hysteria* it is differentiated by the absence of stigmata and the care a hysteric patient exhibits to avoid injury to himself, and by the peculiar electric reaction. Myotonia atrophica resembles it (p. 1209).

The **prognosis** is hopeless. The disease commences in early life and continues until death, with more or less frequent remissions and exacerbations. It is possible that these remissions may be permanent, and one case has been reported of a young woman whom marriage greatly benefited. The disease is rarely dangerous to life, except in so far that those who suffer from it are much more liable to injury.

Treatment is exceedingly unsatisfactory. Practically nothing can be done, although in a few cases systematic stimulation of the muscles has produced some mitigation. The patients often learn methods by which they can at least diminish the unpleasant symptoms. Certain movements seem to prevent or shorten the period of tonic contraction. Of course exposure to cold or emotional disturbance should be avoided as far as possible.

MYOTONIA CONGENITA

(*Amyotonia Congenita*)

This disease, first described by Oppenheim in 1900, occurs in early childhood, and is characterized by a more or less general hypotonia of the muscles. There is flaccidity of the limbs, especially the lower, and all of the joints are abnormally movable. Muscular power is much diminished. The deep re-

flexes are either diminished or lost. The electric reactions are either quantitatively diminished or lost. The mental faculties are not impaired. The fact that it is a congenital but not a hereditary disease distinguishes it from the dystrophies. It differs from amaurotic family idiocy in the absence of blindness and mental impairment. In Spiller's case disease of the muscles was found, and there was also a lesion of the thymus gland. Oppenheim believed it to be due to an arrested development of the muscle.

The disease is not necessarily fatal, and measures to improve the nutrition of the muscles (massage, electricity, etc.) may be of service.

MYASTHENIA GRAVIS

(*Asthenic Bulbar Paralysis*)

The exact classification of this disease is still a matter of dispute. The only definite changes that have been found are the electric reactions in the muscles. It is characterized by progressive weakness in the muscles, an increased susceptibility to fatigue, and the occurrence of the myasthenic reaction. The **etiology** is unknown. Possibly infectious processes may have something to do with it; but it bears no definite relation to syphilis. Pathologic changes have not been found. Pemberton has suggested that it is a derangement of metabolism evidenced by an increased calcium and reduced creatinin output. The muscles of deglutition, mastication, and speech, and the group of muscles controlling the eyes are particularly affected; sometimes one group, sometimes another being first involved. The muscles of the body also become weaker. There may be dyspnea, and even difficulty in walking. The most peculiar feature is the rapidly developing fatigue in the muscles when they have been used. Thus, if the patient attempts to lift the arm a number of times, each successive motion will be weaker than the previous, until finally complete paralysis ensues. If the eyes have been held open for any length of time the upper lid will droop until there is a transient but complete ptosis. The muscles also exhibit the so-called *myasthenic reaction*. Upon repeated application of the faradic current the muscles contract less and less vigorously, until finally the capacity for contraction appears to be exhausted, to return after a period of rest.

The **course** of the disease is variable. There are remissions more or less complete and prolonged, but ultimately the patient dies of progressive exhaustion or of increasing dyspnea. Occasionally patients have strangled while attempting to swallow. It has been noticed in women that the symptoms are always increased during menstruation.

The **diagnosis** is to be made from bulbar paralysis. The symptoms resemble each other very closely. In bulbar paralysis there is usually complete reaction of degeneration in the affected muscles. The myasthenic reaction is absent, and in the unaffected muscles the susceptibility to fatigue is not particularly increased. If the patient has been observed for any length of time, the remissions in the course are in favor of myasthenia. In poliomyelitis superior or acute lesion of the oculomotor nuclei, the sudden onset and permanent weakness also serve to make the distinction.

Treatment appears to be entirely without avail. Strychnin hypodermically appears to be useless; electricity is harmful. Full doses of calcium salts may be tried. The patient should be put absolutely at rest, and all sources of worry should be avoided. If there is difficulty in swallowing, the stomach-tube may be employed with advantage.

space and into the ventricles have been noted. The nerve-cells, nerve-centers, and nerve-fibers show degeneration, hardening, and atrophy. Alcoholic neuritis is especially prominent in many cases.

The symptoms of acute alcoholism range from mild intoxication to an acute delirium or a profound stupor and coma. It begins with the stage of *vascular relaxation* and of feelings of warmth and exhilaration, due to the depressing and paralyzing effects of the alcohol upon the vasomotor tone. The second stage is one of *partial functional paralysis of the nerve-centers*, marked disturbance of the faculties, muscular inco-ordination, and delirious speech. In the third stage, of "dead-drunkenness," there are acute coma, stertorous breathing, a bloated and congested face, a slow and full, but weak, pulse, a cold and clammy skin, a heavy alcoholic odor of the breath, and, sometimes, incontinence of urine and feces. It frequently happens that unconsciousness is not so profound but that the patient may be aroused, though replies to questioning are stupid and incoherent. Ordinary acute alcoholism seldom passes beyond a stage of exhilaration, ending in mild narcosis. Sometimes, however, the irritant action of the alcohol predominates over its narcotic action, giving rise to acute alcoholic gastritis or nephritis.

Acute mental disorders (*acute alcoholic insanity*) are not infrequently met with. *Mania-a-potu* may come on quite suddenly in debauchees, or in those who have drunk hard during a short time, as in a night's carousal. The mental excitability increases until a violent maniacal storm not unlike the mania of epilepsy possesses the drinker. While in this state of infuriated delirium homicide may be committed. Tremors are absent. *Acute alcoholic melancholia* develops suddenly in some cases, with a suicidal tendency. *Delirium tremens* is more common in alcoholic inebriates, and is also seen at times in those who drink greatly to excess, but are not habitués.

Chronic alcoholism (alcoholic inebriety) I consider a true disease. The steady, so-called "moderate drinker" who saturates his blood and tissues every day for years is much more apt to suffer from chronic alcoholic poisoning with its attendant degenerations than one who goes on a "spree" once a month for a day or two, and during the intervals is free from the toxic influence of alcohol. The symptoms develop very gradually, and are usually marked for some time by the deceptive sensation of stimulation, warmth, and well-being, due to the vasomotor paresis and the anesthetic effects of the alcohol. Impairment of digestion is early noted. There are a coated tongue, foul breath, vomiting before breakfast, and gastric distress after eating. Gastritis and achylia, caused not only by the alcohol but also the irregular meals and habits of life of the addicts, are present as a rule. Constipation alternating with diarrhea is common. Muscular tremors gradually develop and often progress into an ataxic gait. Insomnia, mental impairment, and blunting of the moral sense come on. "Alcohol dims the perception, confuses the judgment, paralyzes the will, and deadens the conscience" (Kerr).

Dementia is often the terminal state of the chronic inebriate. Delusions of persecution are frequent, especially those of marital infidelity, in alcoholic insanity. The liver is either fatty and enlarged, or cirrhotic and contracted, and jaundice, dropsy, and hemorrhoids, along with physical hepatic signs, are correspondingly observed. The watery eye, the injected conjunctivæ, the swollen eyelids, the bloated and flabby or pallid and shrunken face, the dilated capillaries of the nose (*acne rosacea*) and cheeks may now be seen. The urinary examination will show in many cases the deranged function of the kidneys and point to the nature of structural impairment. On account of the weak and flabby heart there are palpitations, dyspnea, and precordial distress, and occasionally sharp pains. Chronic valvular endocarditis may be discovered.

The pulse is soft and weak in beginning fatty degeneration of the vessels. Thickened arteries are common in old cases, and the pulsations are often increased in tension and usually rapid. Muscular capacity and endurance are greatly diminished.

Delirium tremens occurs in the majority of cases in inebriates or chronic drinkers during or after a debauch, and particularly from the use of spirituous liquors. It may occur, also, during abstinence from alcohol, on account of some mental perturbation, or fright, accidental shock, or acute inflammatory illness. It may either come on suddenly, or be preceded (often for a day) by some slight premonitory symptom, as anorexia, restlessness, or depression of spirits. The patient usually awakens at night with a tremor, becomes sleepless, wants to get out of bed to do some imaginary thing, talks constantly and incoherently, looks about uneasily and fearfully, and breaks gradually into a cool perspiration. Hallucinations of sight, hearing, and smell develop. The muscular tremors increase, the pulse becomes frequent and weak, and the tongue coated with a thick white fur. There is moderate fever, which, if the delirium is prolonged, takes on a typhoid character. In favorable cases improvement begins on the third or fourth day, from which time the symptoms gradually subside. Convalescence may be said to be established when restful sleep can be obtained; this is followed by a desire for food. In unfavorable cases the patient may pass from a typhoid state into exhaustion and death, or may die suddenly either during a paroxysm of cardiac failure or from some complication, as cerebral hemorrhage or pneumonia.

Korsakow's psychosis, or the mental symptoms that may occur in connection with alcoholic neuritis, is described on page 1044.

Diagnosis.—The condition of persons found dead-drunk is seldom mistaken for any other. The reverse more often happens, and in this way *apoplectic* and *uremic comas* may be diagnosed as alcoholic coma. *Congestion* and *lobar pneumonia* affecting the bases of the lungs should be looked for, as they are common causes of death in drunkards. A table giving the principal points in the differential diagnosis will be found under Uremia (*vide* p. 964).

The diagnosis of chronic alcoholism is made from the history, and from the muscular tremors (worse in the morning), vomiting, mental restlessness, "mendacity," and involuntary "lying" (Kerr). The condition may resemble general paralysis, and if the habits of the patient are kept secret it may be very difficult to differentiate these affections. A prominence of disorder of the digestive tract usually points to alcoholism. Nervous excitement, tremors, fear, wakefulness, and the distinctive physiognomy are more evident in chronic alcoholism, even when general paralysis has been caused by alcohol, which is apparently the case. *Paralysis agitans*, *locomotor ataxia*, *epilepsy*, and *nervous dyspepsia* may also be mistaken for chronic alcoholism by the unwary.

Delirium tremens is distinguished by the history, by the restlessness, delirium, hallucinations, tremors, and terrors. *Mania à potu* differs from the preceding mainly in its usual association with acute alcoholism, in neurotics, in the muscular contractions, the furious mania, and convulsive movements. The delirium of *apical pneumonia* that obtains in some cases (as well as in meningitis) must be thought of in the diagnosis of delirium tremens. The diagnosis of *alcoholic neuritis* from other conditions simulating it will be found elsewhere (*vide* p. 1044).

Prognosis.—In acute alcoholism the prognosis is favorable in private, manageable cases. The tissue changes in chronic alcoholism are so profound, and they affect such delicate and vital tissues, that when the alcohol habit thus becomes fixed permanent recovery never takes place. Insanity and paresis are not infrequent terminations of chronic alcoholism. Many complications

are apt to supervene, as Bright's disease, epilepsy, melancholia, fatty heart, pneumonia, and thrombosis. Alcoholic neuritis often clears up upon withholding alcohol and stimulating the peripheral nerves both by appropriate drugs and external remedial measures. Recovery from delirium tremens is dubious in cases of severe injury, inflammatory troubles, or infections.

Treatment.—In cases of acute drunkenness, which are only too commonly met with, nothing special is required except to prevent the ingestion of any more alcohol and to allow the patient to sleep until the elimination of the poison is more or less complete.

In profound cases of alcoholic coma, convulsions, or mania à potu no alcohol should be given. It is often necessary to empty the stomach at once when collapse is imminent by the use of the stomach-tube or pump, washing out the organ with hot water, to which ginger or cinnamon has been added. To this end emetics may be used—viz., ipecac or apomorphin, hypodermically (gr. $\frac{1}{8}$ to $\frac{1}{4}$ —0.008–0.01). The external application of warmth, friction, artificial respiration, faradism to the phrenic nerve, ammonia or amyl nitrite inhalations, and hypodermics of atropin, strychnin, and digitalis, may all be tried. Hot rectal enemata or a calomel purge, if the stomach will tolerate the drug, should be used early. The maniacal attacks may be treated by hypodermics of morphin and hyoscin, and by such sedatives as chloral, bromids in large doses (3j—4.0), and rarely such hypnotics as paraldehyd, trional, chloral-amid, and the like.

The treatment of *chronic alcoholism* is more often best conducted in “homes” for inebriates, in hospitals, and similar institutions. A. Lambert believes that the majority of periodic drinkers who are endeavoring hopelessly to cease their periodic sprees are really cases of chronic tobacco poisoning (*e. g.*, incessant cigarette smokers). At the outset there must be an “unconditional surrender” in the use of alcohol. Its withdrawal should be enforced at once in many cases, and very rapidly in all others, according to the judgment of the physician as to the psychic and physical condition of the patient. Substitutes for alcohol are the strong fruit-juices, as hot lemonade or hot ginger, capsicum infusion, and cardamom tea often is useful. Coffee, milk, cocoa, and hot broths are also to be recommended. The diet should be carefully increased in nutritive strength as the gastric irritability diminishes. Sometimes such sedatives to the stomach as the bismuth preparations, effervescent alkaline drinks, and lime-water may be indicated. The general health must be looked after by placing the patient in the best of fresh air, exercise, cold and warm bathing, by mental and social occupation, and by diversion. When the craving for alcohol is hereditary and intense, seclusion in an inebriate-house or some similar institution is often necessary for a long time to lessen the danger of lapsing into the former drink habit.

The insomnia of chronic alcoholism may be met temporarily by the use of large doses of bromids, chloral, or hyoscin. Perhaps the best single agent to use in counteracting the symptoms of chronic alcoholism is strychnin, either as the nitrate or sulphate, hypodermically and by the mouth; iron, arsenic, dilute phosphoric acid, quinin, and the like are often useful adjuvants in the tonic treatment. Atropin, hypodermically, may also be recommended when vascular dilatation and weakness are prominent. Sweating and purging the patient, and the administration of bromids, chloral, and gelsemium for a day or two in advance may avert a “drink-storm” or the periodic cravings for alcohol that may be expected by prodromal manifestations.

All the influence of culture, music, and the fine arts, of high-toned morality and pure, undefiled religion should be enlisted to strengthen self-respect and to fortify volition and inhibition. Moral regeneration may thus in certain

cases check the physical and mental degeneration, but it cannot efface the consequences of the alcoholic poisoning which it represents.

The Towns-Lambert method of treatment enjoys an enviable reputation at present writing. In treating an alcoholic, however, the details differ from those suitable in morphinism, as shown by Lambert.¹

Delirium tremens requires firm but tactful isolation and vigilant nursing. All alcohol should be withheld. If stimulation is needed, aromatic spirits of ammonia; strychnin and atropin, with bland hot drinks and broths, may be administered. Easily digested and nutritious food should be given to support the strength. Sleep must be procured by such means as are mentioned above in the treatment for *mania à potu*. The dosage required, however, is usually not as great, but must be kept up longer than in the maniacal condition. Cardiac weakness may need such stimulants as digitalis and strophanthus. Steinbach² has found the symptoms to be relieved by lumbar puncture.

WOOD ALCOHOL (METHYL ALCOHOL) POISONING

The enforcement of national prohibition has resulted, in the few months that the act has been in force, in the reporting of a large number of deaths and many cases of blindness following the ingestion of wood alcohol. This alcohol is made by the destructive distillation of wood, whereas the ethyl alcohol is prepared by fermentation of grains or fruits. Both types are poisonous, but methyl alcohol much more so than ethyl alcohol, which is the alcohol found in beer, wines, whisky, and other so-called alcoholic drinks. The restrictions of the prohibition act in regard to making ethyl alcohol are so strict that little alcohol is now being made, whereas wood alcohol may be made in unlimited quantities, though selling it as a beverage is a criminal offense. This has led to the substitution of methyl alcohol for the ordinary alcohol in the making of drinks, as it may be so prepared as to be indistinguishable by ordinary methods. It may be sold to alcoholic habitués as whisky or gin, or the alcoholic may so crave alcohol that he may knowingly drink it though unaware of the dangers of the substitute that he is imbibing.

The **pathology** of the acute cases of poisoning is simply that of an intense congestion of the gastro-intestinal tract such as occurs after ingestion of any irritative poison. In addition, there is liberated a quite characteristic methyl alcohol odor when the stomach and intestines are opened. In practically all lethal terminations of this type of poisoning there may be demonstrated a marked optic neuritis.

The **symptoms** vary in degree from those of an ordinary mild intoxication to a severe prostration resulting rapidly in coma and death. In the intermediate cases the gastro-intestinal symptoms are well marked. The patient feels weak and exhausted and complains of failing vision as the acute symptoms of intoxication pass off. Examination shows a well-marked cyanosis, dilated pupils, often not reacting to light, a rapid, weak pulse, deep and rapid respirations, and a subnormal temperature. The patient may become unconscious or delirious or deep coma may follow the unconsciousness. If coma supervenes, death usually occurs, apparently in part the result of a severe acidosis. If the patient recovers, dimness of vision may be noticed, which may pass on to complete blindness. Vision may also be temporarily destroyed, to pass on in days or weeks to almost complete or to complete blindness, with atrophy of the optic nerve.

The **diagnosis** is made largely on the history of the case plus the manifestations of ocular disturbance. When the direct evidence of wood alcohol poison-

¹ *Jour. Amer. Med. Assoc.*, February, 18, 1911, p. 503.

² *Deutsch. Med. Woch.*, 1915, xli, 369.

ing is lacking or when there is a medicolegal aspect to the case, formic acid, an excretory product of methyl alcohol, will be found to be excreted in the urine in large quantities by appropriate quantitative chemical methods. The Philadelphia Department of Health recommends the following test: "A bright copper wire 12 inches long is twisted at its end in a spiral manner for 1 inch. This spiral tip is held over a blue flame until a black deposit in the form of scales appears upon the bright surface of the wire.

"The copper spiral with its deposit of copper oxid is again held in the blue flame until it becomes red. This heated spiral is then plunged into a well-diluted sample of the suspected liquid (1 part liquid to 10 parts of water), about a tablespoonful of the diluted sample in an ordinary tea cup. The spiral is then taken out, reheated, and again plunged into the suspected liquid. This maneuver is repeated about a dozen times. There is thus formed in the suspected liquid free formaldehyd. To the liquid in the tea cup is then added a tablespoonful of milk and half as much commercial muriatic acid. The contents of the tea cup then assumes a bright violet color, indicating the presence of wood alcohol. This test is so sensitive that one part of wood alcohol in a million can be detected."

Of course, the test for wood alcohol is best performed by a chemist.

The treatment when the patient is seen early consists of gastric lavage and castor oil and enemas to cleanse the intestinal tract. The patient must be stimulated by hypodermic injection of strychnin or caffein sodium benzoate. Heat should also be applied as well as the methods to combat shock. Recently Harrop and Benedict,¹ as a result of careful study of a case of wood alcohol poisoning in which they found there was a marked acidosis, have advocated intravenous injections of 5 per cent. sodium bicarbonate solution, 500 c.c. repeated in eight to twelve hours. The latter treatment of the condition when the patient is seen in the stage of coma or unconsciousness consists of active stimulation. The methods advocated for relief of the eye condition seem to be of little value in severe cases, though potassium iodid, pilocarpin, and sweat baths at first, followed, when the patient's condition permits, by strychnin hypodermically are the best methods to limit the secondary atrophy, according to Lambert.

GINGER AND COLOGNE-WATER INEBRIETY

Habitual drinkers of alcoholic ginger, capsicum, and lavender preparations, and eau-de-Cologne are practically alcohol habitués or inebriates. They drink these liquids for the alcohol that is in them. The so-called essence of ginger (Jamaica ginger), which contains considerable alcohol in some of its preparations, is often used primarily for relieving an attack of "cramps" or "colic," and if frequently repeated, can readily induce a morbid habit of "ginger-drinking." In other cases the craving for alcoholic indulgence (often hereditary), may have been aroused by a social glass of wine, but, from a sense of shame the desire has been kept secret, and gratified by drinking eau-de-Cologne, lavender essence, or even tincture of capsicum. Perhaps many more such cases exist, and especially among neurotic women in good circumstances, than are usually recognized.

OPIUM-POISONING

Definition.—A chronic intoxication due to the habitual use of opium (*opiumism*) or its alkaloids.

Pathology.—In cases of death from acute or chronic opium- or morphin-poisoning there is nothing distinctive in the pathologic appearances. In acute

¹ *Jour. Amer. Med. Assoc.*, 1920, lxxiv, 25.

cases vascular congestion of the brain and membranes has been noted; but even in chronic cases the tissue degeneration and fatty and connective-tissue proliferations that are characteristic of alcoholism, are practically absent. Decided lesions are usually traceable to associated affections. The principal anatomic changes are those due simply to malnutrition. Thus, we have the emaciation and the shrunken appearance of cerebral anemia, and pallor and atrophy of the cardiac muscle and of the vascular walls. The dried and wasted structures, due to tissue starvation, are quite a contrast to the fat-infiltrated or degenerated, cirrhotic, and inflamed tissue of alcoholic inebriety. Direct destruction of parenchymatous cells is more evident in the latter.

Etiology.—The climate, country, and nationality have a certain disposing influence in the development of opiumism and morphinism. In the opium-growing parts of Asia, as in China, India, and Persia, where the climate is warm, enervating, and conducive to physical and moral abandonment during the greater part of the year, and in Turkey also, opium-eating and -smoking habitués are as numerous as alcohol habitués are in Europe and America among the Caucasians.

Women are more commonly the victims of morphinism than men, except physicians and druggists as a class.

Ennui and an idle spirit of irritation and adventure among the sensation-loving and luxurious sometimes sow the seeds of an indulgence in narcotics that bring forth fruitage in the form of a fixed habit.

The incautious prescribing of morphin and the too ready hypodermic use of the alkaloid by physicians in treating various cases of pain are not infrequently the cause of morphinism. Overwork of the brain, great business or social strains, prolonged worry and anxiety either with or without work, insomnia, remorse, idleness, and secret vices, are the most common predisposing agents of the morphin habit.

Paregoric, laudanum, chlorodyne, and "soothing-syrup" are drunk to a frightful extent in large cities among the poor and miserable, and cause great disturbance of the health of the habitués. Heroin is being used to an alarming extent in spite of all efforts to limit its sale.

Symptoms.—These may be in abeyance for some time, while the habit is forming and the doses are still slight. As the craving increases, the dose and its frequency increase to keep pace with the desire. Anemia gradually develops, with sallowness of the skin, wasting of the features and body, languor, weakness, functional deterioration, mental depression, anorexia, restlessness, insomnia, tremors, irritability, shyness, dilatation of the pupils (except when under the influence of the drug), and a characteristic propensity to lying. Cardialgia is often complained of by those who use opium pretty constantly. The associated vices of opiumism are less violent and inflammatory than those of alcoholism, and more secretive and speculative, such as gambling and sexual perversions. Itching is frequent, and especially after taking the opium or morphin. Attacks of chills, followed by pyrexia, with delirium and transient albuminuria (renal congestion) occur in some cases. Diarrhea and dysentery have been observed in some instances. There may be also disturbances of the visual muscular apparatus. Sufferers from painful carcinoma in whom opium or morphin is required for steady use do not become, except in rare cases, true morphinomaniacs.

The *course* of morphinism is that of a progressive asthenia, in which cardiac palpitation, dyspnea, abdominal and muscular cramps, trembling, fear, sleeplessness, mental confusion, melancholy, slovenliness, and moral obtuseness come on. Some women, known to be kleptomaniacs, have been found to be secret opiumists. Sexual impotence in the male, and amenorrhea and abortion

in the female, are common results. The skin is wrinkled, dry, and harsh, and may show numerous needle-scars and abscesses in those addicted to the hypodermic use of the drug. The *termination* is the direct result of the extreme debility or marasmus or of some intercurrent affection.

The **diagnosis** must be made from the history. When the latter is wanting because of a lack of veracity or deception, *chronic alcoholism* may have to be differentiated from opiumism. The more open and often periodic habits of the alcoholic habitué, and the general aspect of the physical and mental and complicating conditions, usually show marked differences between the two drug intoxications.

Prognosis.—The likelihood of a cure is exceedingly remote. On the other hand, under proper conditions much relief may be given and life prolonged for years. Opium smoking produces less injurious consequences, and is more readily cured than other forms of the addiction.

The **treatment** is manifestly difficult and unpromising. Institutional isolation, rest, diversion, watchful care, regular and studied feeding, baths, and graduated exercise in the open air as far as possible, but under surveillance in order to prevent the smuggling of opium, morphin, heroin, or compound preparations containing them, are the most efficient measures. As to the manner of withdrawing the narcotic, much care, judgment, and tact form a *sine quâ non* in the treatment. A sudden and absolute stoppage of the use of the drug sometimes leads to great distress, and even to collapse ("abstinence phenomena"); it is, therefore, not to be recommended, as in chronic alcoholism. On the other hand, the too gradual withdrawal is torturing. A middle course, the "rapid-gradual method" of Erlenmeyer, is usually resorted to, in which the reduction of the quantity of morphin or opium to nothing occupies but a week or ten days. Various substitutes have been recommended that generally prove not to be substitutes at all, but simply act in a symptomatic way, and may lead to another habit as bad if not worse. Such drugs as cocain, hyoscyamus, bromids, and chloral have thus been used. Hare and others have reported good results from the method of treatment suggested by Lott, namely, by the use of hyoscin hypodermically in large doses (gr. $\frac{1}{100}$ —0.0006 every two hours) until the patient is rendered calm or even unconscious, after which this state is to be maintained for several days and then the dose is to be gradually diminished so as to permit a return to the normal condition. Cardiac stimulants may be needed. The Towns-Lambert method of treatment is now widely adopted, and the results which have been recorded in literature are most promising.¹

In the symptomatic treatment of the morphin habit moderate doses of bromids, with cannabis indica and some such vegetable bitter as gentian, may prove useful in allaying the nervous irritability and restlessness at night. Cathartics, stomach sedatives alternating with tonics, concentrated foods, massage, hot and cold bathing, electricity (general galvanization), and "complete control over the patient" are usually indispensable adjuncts in the treatment after the withdrawal of the opium or morphin. Cardiac stimulants, strychnin and physostigmin salicylate (gr. $\frac{1}{100}$ —0.0006) hypodermically, have been recommended recently as important in counteracting the functional depression of these habitués. Industrial activity, and mental and social diversion aid in maintaining any improvement made and in rendering the patient less liable to a relapse.

¹ For details, see *The Jour. Amer. Med. Assoc.*, February 18, 1911, p. 503.

PLUMBISM

(Chronic Lead-poisoning; Saturnism)

Definition.—A chronic intoxication due to the slow absorption of lead, either industrially or accidentally.

Pathology.—The principal lesions are found in the muscles, peripheral nerves, liver, kidneys, and mucous membranes. The affected muscles are wasted, pale-yellow in color, and, in advanced cases, show a marked fibroid growth. The vessels in the muscles also reveal arteriosclerosis. The peripheral nerves are affected with a parenchymatous neuritis, and are especially involved, with degenerative changes in the nerve-endings in the muscles. The nearer we approach the spinal cord along the course of an affected motor nerve, the less marked are the changes, although in some cases a very slight involvement of the anterior nerve-root cells has been noted. The cord is usually normal.

In the brain, slight meningitis and arteriosclerosis of the cerebral blood-vessels here and there, with a corresponding connective-tissue growth and capillary hemorrhages. The liver and kidneys show parenchymatous atrophy and cirrhosis.

Etiology.—(a) *Personal susceptibility* to lead-poisoning is greater in some people than in others, all other things being equal. (b) Plumbism is more common in *adults* than in *children*, because of greater exposure. (c) *Sex.*—Women are more susceptible than men. (d) *Occupation* is the most frequent cause of lead-intoxication. Workers in white lead (plumbic carbonate), red lead, and litharge, all of which substances are used as paints, are especially to be mentioned as liable to saturnism. Among the most common industrial causes are the following: painting, plumbing, lead-mining, rolling sheet-lead, pottery glazing, type-founding and setting, shot-making, dressmaking (in which lead-dyed silk thread is used and the ends bitten off), lace-making, glass-grinding, and calico-printing. (e) Accidental contamination of food and drink. Men employed in the manufacture of white lead and eating lunches in dusty work-rooms suffer from plumbism. Drinking-water stored in lead-lined cisterns, and passed through lead pipes is frequently contaminated, especially if the water contains a slight amount of acid. Flour, bread, biscuit, candy, butter, and milk may cause poisoning by adulteration with lead chromate, used to give a rich, yellow tint to these articles; and tobacco wrapped in lead-foil has resulted in saturnism. (f) Workers in lead suffer more frequently during the warm season. (g) Previous attacks greatly increase susceptibility.

The *absorption* of the lead takes place mainly through the gastro-intestinal tract, including its inhalation as dust, followed by swallowing, and absorption from the skin or an abraded surface. It may be deposited in most of the soft tissues and viscera, but especially in the nerves, muscles, and liver. *Elimination* takes place through the kidneys, and probably, though in very slight quantities, with the bile and saliva, and through the skin.

Symptoms.—Depending upon individual susceptibility, it may be months or years before the first manifestations appear. *Anemia* is an early and marked symptom. The red cells and hemoglobin are reduced correlatively. Boston, in the study of 24 cases, found the leukocytes to number between 10,000 to 23,000 per cubic millimeter; an average of 12,600. The erythrocytes are pale, distorted, and show evidence of punctate basophilic degeneration. Grawitz and Frey regard polychromatophilia as an important blood finding (Need). The general nutrition is poor.

The characteristic *blue line* at the borders of the gums is rarely absent, especially in those who are not scrupulous in their attention to the teeth. It is, as a rule, most distinct at the roots of the lower canines and incisors, and

is formed by a deposition of lead sulphid. Bluish patches may also be met with. Gowers points out that this line is black instead of blue, and is present only when the gums are slightly separated from the teeth. Slight jaundice may at times be noted.

Colic is very common and is also characteristic. The pains center around the navel, and are quite severe and griping. They are associated with retraction and rigidity of the abdominal walls, and with obstinate constipation. The pains are paroxysmal, may be referred at times to the epigastrium, and may be accompanied by vomiting. Between the paroxysms a dull pain usually exists over the whole abdomen. During the attacks the pulse-tension is increased and cardiac action lessened. The stomach contents show no HCl as a rule.

Exaggerated tendon reflexes may be present early. *Paralyses* are common symptoms, and may either be acute, subacute, or chronic in nature. Although usually localized, palsies are sometimes generalized. The most characteristic lead-palsy is that known as *wrist-drop* (see also Multiple Neuritis, p. 1044). Both fine and coarse *tremors* occur. They usually begin in the hands and arms, are rather constant, and are aggravated by *voluntary effort* and emotional excitement.

Cramps in the affected muscles and about the joints (*lead-arthritis*) are occasionally noted. Slight anesthesia, especially in cases of wrist-drop, is sometimes detected here and there, but may in certain instances be due to saturnine hysteria.

The *cerebral symptoms* are important. The phrase "lead encephalopathy" includes such manifestations as delirium and coma, neuroretinitis, aphasia, convulsions, hemiplegia, amaurosis, hysteria, and insanity. The delirium and coma are the commonest brain symptoms, and may come on suddenly with tremors and hallucination. Epileptic convulsions are often severe. Hemianopsia has been observed. Mania and melancholia occur in cases of mental unbalancing, and hysteric outbreaks are seen in girls. Intense headache is not uncommon. "Saturnine gout," so called, is described as a result of chronic plumbism. The kidneys are contracted, the heart is hypertrophied, and arteriosclerosis is marked, with a diminution in the excretion of urea and uric acid. The pulse-tension is increased. These evidences show a similarity to gout, and favor the development of uratic deposits in the joints. Lead may be discovered in the urine by laying a strip of magnesium in it and noting the deposit of metallic lead if present (Von Jaksch). Abram asserts that the addition of a solution of ammonium oxalate (1 gm. to 150 c.c. of water) facilitates the test. Hematoporphyrin may be found in the urine. Chronic parotitis and lead-poisoning were encountered in 12 cases by Comby.

Diagnosis.—The history of exposure to lead-poisoning is usually clear in those working the metal in its various forms. *Accidental origins* of saturnism are often obscure and very difficult to trace, although if the characteristic wrist-drop, the gingival line, colic, and cachexia be present, the diagnosis is readily made.

Alcoholic paralysis of the lower extremities may be differentiated by the history, the greater prominence of sensory symptoms, and by the absence of the blue line on the gums, and of punctate basophilia.

Prognosis.—In the absence of the graver nervous, arterial, and renal symptoms, the prognosis is good. When there is paralysis, with reactions of degeneration, and especially in primary atrophy of the muscles, the prognosis is generally bad. In encephalopathic forms, and in cases in which arteriosclerosis and renal cirrhosis are manifested, the prognosis is unfavorable, but depends upon the extent of damage done. Pulmonary tuberculosis often complicates lead intoxication.

Treatment.—The prevention of plumbism is difficult in lead-working establishments, owing to the carelessness and indifference of both employers and employees, and to the lack of any adequate antidote during exposure. Rigid cleanliness is absolutely necessary, especially of the hands and nails and before eating. Means to allay dust should be regularly and constantly employed. Milk and sulphuric acid lemonade have been recommended for use by workers in lead, for their supposed antidotal effects. As perfect ventilation as possible should be secured, and respirators are in use in some lead-works, being worn as “snouts.” Potassium iodid should be given in chronic plumbism, beginning with small doses (gr. iii to v—0.2–0.3), given preferably in milk, after meals.

In *lead-colic* hot applications to the abdomen and hypodermic injections of morphin and atropin are often indicated. Efficient doses of Epsom or Glauber’s salts are used to combat the constipation. Given in combination with dilute sulphuric acid (in order to form an insoluble lead sulphate) and with belladonna, the best and speediest benefits may be obtained thereby.

Iron for the anemia, strychnin and galvanism for the paralysis, mild diuretics for the renal deterioration, and nitroglycerin or sodium nitrite for the arteriosclerosis (enough to relieve increasing tension) are the symptomatic items of treatment that are usually indicated. Rarely, hopeless cases of saturnine encephalopathy need to be sent to asylums for the insane.

ARSENICISM

(*Chronic Arsenic-poisoning*)

Definition.—A chronic intoxication resulting from the gradual absorption of arsenic.

Pathology.—The peripheral nerves show a degenerative neuritis, and the anterior horns of the spinal cord may be similarly affected.

Etiology.—The causes of arsenicism may be habitual, industrial, medicinal or accidental, and individual predisposition varies. A neurotic diathesis usually underlies the habit of “arsenic-eating” in those who crave the drug. Not a few women suffer from chronic arsenicism as the result of the ingestion of arsenic “to improve the complexion and brilliancy of the eye.” Men employed in arsenic works of various kinds often suffer from the chronic poisoning. For example, miners and smelters of arsenic pyrites, dyers and wall-paper workers using Scheele’s or Schweinfurth’s green, artificial-flower makers, shot-makers, glass-workers, and taxidermists, are all liable on account of their occupations. The medicinal use of arsenic, even for a short time, may in very susceptible persons induce arsenical paralysis (Putnam, Osler). Again, “cancer cures” containing arsenic may cause poisonous effects. Accidental arsenicism may come from living in rooms where wall-paper, carpets, colored paper ornaments, toys, or curtains are contaminated with arsenic anilin dyes. Drinkers of beer may suffer, the arsenic being derived from the sulphuric acid used in manufacturing the glucose that is employed in its manufacture.

Symptoms.—There are anemia, loss of flesh and strength, dryness and irritation of the mucosæ, of the eyes, nose, throat, and upper respiratory tract. Anorexia, nausea, and diarrhea indicate the presence of a gastrointestinal catarrh. In some cases, milder than others, the fat is well preserved. Slight puffiness of the eyelids or eyebrows may occur, and some epigastric distress may be complained of. Marked conjunctivitis, occasional dysenteric attacks, loss of the hair, and numbness and tingling in the extremities form a commonly observed symptom group. Cutaneous symptoms may appear, as pigmentation (“arsenic bronzing”), keratosis, and eczematous, herpetic, urticarial, and pemphigoid manifestations. Albuminuria with casts and blood

mark the renal irritation that sometimes occurs. A high blood-pressure is frequently seen.

The most characteristic evidence of chronic arsenic-poisoning is seen in the gradual increasing diffuse or multiple neuritis. Differing from lead-palsy, the leg-extensors and the peroneal group of muscles are involved first, although the arms may also become affected later (*vide* Multiple Neuritis, p. 1044). Contractions in the lower and a finer tremor of the upper extremities are apt to occur. Arsenic-poisoning may also cause headache, vertigo, melancholia, and hysteria. The drug is eliminated by the kidneys and may be found in the urine. Sometimes a great toleration of arsenic is observed in workmen and habitués, the only evidences being a clear, sallow, waxy complexion, a gloomy expression, and some dyspepsia, perhaps, as in the well-known Styrians.

Diagnosis.—This is not difficult when once the source of the poisoning is determined. The clinical appearances are distinct from *lead-intoxication*, especially in the mode of progress of the paralysis, and in the more marked sensory symptoms combined with the motor disturbances of arsenicism. Arsenic should be sought for in the urine.

The **prognosis** is favorable in most cases in which removal from the exposure to the influence of arsenic is possible. A few cases die from the great general debility.

Treatment.—Abstention from the use of arsenic for cosmetic purposes, avoidance of its influence in the arts, care in its medicinal administration, and prophylaxis as regards the possible or discovered sources of contamination, form the first considerations in the treatment. Elimination of the arsenic may be promoted by the use of potassium iodid and purgatives. Gastro-intestinal and other irritations must be met by appropriate sedative remedies. The neuritis and palsies require—as soon as the tenderness and pain subside—massage and electricity. Judicious and wholesome alimentation and tonics are indicated.

MERCURIALISM

(Chronic Mercurial Poisoning)

Definition.—A chronic intoxication caused by the habitual ingestion or combined industrial absorption of mercury in susceptible individuals.

Pathology.—No marked pathologic changes have been noted in human beings aside from the evidences of oral, gastro-intestinal, and renal irritation and inflammation. It is not improbable that the cerebral cortical areas suffer more from metallic irritation than do the spinal or peripheral nerve tissues.

Etiology.—Some persons are much more easily mercurialized than others. (a) *Salivation* and *stomatitis* from the therapeutic use of mercury form a variety that is less frequent than formerly. (b) *Industrial origin.* The chief cause of chronic mercurialism is the inhalation of the vapor of the metal by artisans in the industries in which it is used. Thus miners and smelters and those engaged in making mirrors, barometers, thermometers, amalgams, felt hats, vermilion pigment, and artificial teeth sometimes suffer from chronic mercurial poisoning. It should be pointed out here that mercury is volatile at ordinary temperatures, and is absorbed into the blood through the lungs, digestive tract, and skin. Calomel vapor-baths have caused poisoning in a few cases. (c) Purely *accidental* mercurialization also occurs. (d) Women and children are more susceptible to the action of mercury than men. In all cases the mercury exists in the tissues as an albuminate.

Symptoms.—There are anemia, emaciation, gastro-intestinal disorders, stomatitis, salivation, maxillary necrosis, ulceration of the gums, loosening of

the teeth, fetor of the breath, marked tremors, and paralysis. The oral symptoms are not as prominent, however, as in acute mercurial poisoning. The hair falls out, the nails become brittle, and pigmentation of the skin is seen.

The *tremor* is characteristic. It is first felt or noticed in the tongue and lips, is usually fine, later coarse and choreiform, and spreads gradually throughout the muscular system. It is aggravated by voluntary effort, and may cease during sleep in mild cases. Speech is altered. Hysteric tremors may also exist. Great irritability and restlessness are common. Aphasia, hemiplegia, hemianesthesia, and peripheral neuritis with palsies, occur. There is no atrophy, nor are the reactions of degeneration present in the paralyzed muscles. Severe pains may be present in the extremities, including the joints, and grave cerebral symptoms occasionally develop (stupidity, headache, loss of memory, insomnia, hallucinations, delirium, coma, convulsions, and confusional insanity). Albuminuria with anasarca may occur. The effects of chronic hydrargyris in women upon their offspring are also important, the children being rachitic, weak, sickly, and prone to tuberculosis.

Diagnosis.—The history, the characteristic tremors, paresis, and mental irritability are significant. In the absence of a history of exposure to mercury, the differentiation from *progressive general paresis*, *disseminated sclerosis*, or *paralysis agitans* may be more or less difficult.

Prognosis.—Recovery is common upon the removal of the source or on removing the patient from the source of the poisoning. Fatal terminations rarely ensue, and then in cases of mercurial encephalopathy of a grave type and with a tendency to idiocy.

Treatment.—Prevention of further poisoning is imperative, and elimination is to be promoted. Potassium chlorate, with the tincture of myrrh, and astringents are useful for the occasional stomatitis and salivation. Potassium iodid and also sulphur baths may be used to aid in the elimination of the mercury. Iron, cod-liver oil, good food and fresh air, and a free activity, of the emunctories are useful. For the marked tremor, sedatives (*e. g.*, codein, chloral, bromids, belladonna) are recommended. Electricity may be resorted to for the paresis.

In acute mercurialization, usually accidental, the symptoms are similar to those belonging to the chronic form, although more pronounced, particularly the degree of anuria.

In the treatment of acute bichlorid of mercury poisoning Weiss has used the principle of colloidal swelling described by Fischer as the basis of his treatment. He gives alkaline hypertonic salts by mouth, by rectum, and intravenously, with a pleasant alkaline drink. Sanoum states that therapeutic efforts should be directed toward the accomplishment of two things: (1) Mechanical removal of the poison from the lumen of the alimentary tract, and (2) antidoting the poison before it leaves the portal circuit, that is, particularly before absorption.

FOOD INFECTION AND PTOMAIN-POISONING

In recent years there have been reported an increasing number of cases of serious illness that have been traced to infected and contaminated food. Undoubtedly many such instances are now brought to notice that in former times were attributed to other causes, or that were not diagnosticated because of a lack of knowledge. On the other hand, the increased consumption of canned and preserved meats has certainly augmented the liability to poisoning from these products, as the reports of cases show. Lack of care in the inspection and selection of the meats, uncleanness, and sometimes unscrupulousness in their handling and preparation, must result in infection, putre-

fection, and toxicity. The infection of the food may be due to (1) disease of the animal or plant from which the food is derived; (2) microbic inoculation of the food after derivation and before ingestion by human beings; (3) infection by toxicogenic bacteria, and the presence of ptomains or toxalbumoses. The transmission to man of such affections in animals as tuberculosis, anthrax, glanders, and pleuropneumonia, by eating the infected meat, has been sufficiently proved. Again, meat and milk may become infected before being ingested by the patient, by pathogenic micro-organisms, as of typhoid fever and diphtheria, or from the production of toxins owing to the action of non-pathogenic putrefactive micro-organisms. A great many instances of food infection, particularly of meat and milk, have been shown to be due to the presence of saprophytic germs, this happening even when the articles of food have been obtained from healthy stock and have been kept free from specific pathogenic bacteria. It is not, however, the saprophytes themselves in all cases, but the poison developed in the food before it is eaten or formed in the body afterward, that produce the symptoms and sometimes death. According to Novy, some of the saprophytic bacteria with which food is infected outside of the body, under certain conditions, are capable of living in the body as parasites, especially on dead matter, and there become toxicogenic.

The chronic poisons or ptomains resulting from the action of the saprophytes in foods are called "putrefactive alkaloids"; those bacterial products of a protein nature are called "toxalbumins" or "toxalbumoses." The latter, according to Vaughn, are more frequently present in infected foods. They are all absorbed from the digestive canal.

Poisoning by Infected Milk and Milk-products.—It is now well known that the cause of the high mortality rate among infants in hot weather is traceable directly or indirectly to the "summer diarrheas" in children fed artificially, wholly or partially, with milk infected by numerous varieties of saprophytic germs and thus poisoned by ptomains, such as tyrotoxinon. This special chemical poison has been isolated by Vaughan, and discovered by him in cheese. It has also been found in ice-cream, frozen custards, and cream-puffs, and has caused poisoning symptoms mainly of acute gastro-intestinal inflammation, "constriction of the fauces," nausea and vomiting, sharp, griping intestinal pains, headache, thoracic oppression, chilliness, dizziness, and sometimes purging, followed by relief in mild cases. In the severe and long-continued forms, however, exhaustion may supervene, with subnormal temperature, coma, collapse, and death in the graver cases. No chemical or physiologic antidote is known. Elimination may be assisted, and stimulation is needed. Irrigation may be employed for the former in both stomach and bowels. Strychnin, nitroglycerin, atropin, and the aromatic spirits of ammonia are most effective as stimulants.

Botulism.¹—This is a type of food poisoning caused by the growth of the *Bacillus botulinus* in improperly canned food. Burke² found the organism widely distributed throughout nature. The spores of this anaërobe are capable of withstanding high temperature for long periods, so that most of the cases of poisoning reported in this country have been found to be due to home-canned foods improperly sterilized. Commercially prepared canned foods have rarely been implicated as factors in the causation of poisoning of this type, probably on account of the more complete sterilization of the food by professional canners. The conditions under which home canning is carried on make it difficult to assign the death of this extremely pathogenic organism, which is capable of

¹ For very complete bibliography and additional references see: Dickson, *Mono-graph VIII*, Rockefeller Institute for Med. Research, 1918. Dickson, Burke, and Ward, *Arch. Int. Med.*, 1919, xxiv, 581. Thom, Edmondson, and Geltner, *Jour. Amer. Med. Assoc.*, 1919, lxxiii, 907.

² *Jour. Bacteriol.*, 1919, iv, 541.

resisting steam under 10 pounds pressure for fifteen minutes or a temperature of 100° C. for one hour. However, in the cases of fatal poisoning reported in this country the food has been patently spoiled the majority of times. In all cases there is evidence that the food is spoiled, so that there is little to fear from poisoning of this type if spoiled canned food is discarded and no effort made to salvage portions of it. The evidence of spoiling may vary from a frank decomposition of the food to absence of gross signs of spoiling, but as moderately spoiled food has the odor of butyric acid, an odor resembling "strong" butter, it is fairly easy to detect. In doubtful cases the consumer should be advised to cook the food, as cooking destroys the possible toxin in such material. To obviate the danger of infection of the canned food Thom says that the rejection of infected material at the start of the canning and scrupulous cleanliness are essential.

The *pathologic picture* produced by the experimental poisoning is not definite; hyperemia of internal organs and in some cases hemorrhages in the lungs and abdomen were noted by Thom.

Symptoms.—These may appear from four to thirty-six hours after the injection of infected food. Acute gastro-intestinal symptoms may be first noted; following these a choking sensation is first complained of associated with weakness, and followed shortly by huskiness of the voice, going on to aphasia. In addition to the paralysis of the hypoglossal nerve, partial or complete paralysis of the other cranial nerve groups may occur rapidly, and less frequently palsies of the nerves to the extremities. The patient is extremely nervous, but consciousness is not lost until shortly before death. The respirations become extremely slow and labored and the pulse-rate also falls markedly in rate. Death finally results, apparently from paralysis of the vagus.

The **prognosis** is extremely guarded. Even minute doses of the poison are capable of causing death.

Diagnosis.—The history of having eaten questionable food, followed shortly by symptoms of acute gastro-enteritis and the onset of cranial nerve paralysis, notably of the second, third, fourth, sixth, ninth, and tenth nerves, render the diagnosis an easy one to make. It must not be forgotten that, however, either the gastro-intestinal or the neurologic symptoms may dominate the clinical picture.

Treatment.—Antibotulinus serum should be employed early in doses of from 200,000 to 250,000 units. Prophylactic doses of this serum should be given in all suspected cases. The treatment otherwise, as outlined by Jennings, Haass and Jennings,¹ is gastric lavage, free catharsis by castor oil, sedatives, and supportives.

Meat-poisoning.—Various tainted meats, as mince-meat "warmed over," veal pie, carelessly kept chicken salad, badly preserved and canned meats, partially decayed sausages, have caused violent symptoms of poisoning. Diseased raw and partially cooked meat have also been eaten with disastrous results. Prolonged cooking may fail to destroy the toxic action of certain ptomaines in infected meats; also, that meat that has been cooked and kept under certain conditions may become infected with bacteria as well as when it is raw. Putrid meat, however, has been known not to cause toxic symptoms. Gärtner's bacillus (*Bacillus enteritidis*) is probably the exciting cause of meat-poisoning.

The *symptoms* caused by the poisoning are: "(1) those due to a true infection; (2) those due to simple poisoning" (Mann). Cases of the former group run the usual course of an infectious disease, often simulating typhoid fever. Those under the second division manifest the symptoms of a violent gastro-enteritis, with vomiting, intense colicky pains, purging, fever, accelerated pulse, nervous prostration, great muscular weakness, and cramps in the calves

¹ *Jour. Amer. Med. Assoc.*, 1920, lxxiv, 77.

of the legs. Often a subsequent subnormal temperature, extreme depression, convulsive movement, vertigo, dimness of vision, dyspnea, somnolence, great soreness of the mouth, collapse, and sometimes death supervene. The mortality rate varies from 15 to 55 per cent. of all the cases.

Differential Diagnosis.—Arsenic-poisoning may have symptoms similar to those of ptomain-poisoning. But, as Harrington points out, there are three chief points of difference: in arsenic-poisoning there is swallowing because of pain; in ptomain-poisoning the pupils are usually dilated and the muscular prostration is almost as extreme as a palsy.

The *treatment* is largely eliminative, symptomatic, and supportive. The prophylactic measures, private and public, are generally obvious.

Poisoning by Fish (*Ichthyismus*) and Shellfish.—Many instances of this serious form of intoxication have been produced. The fish may contain certain poison glands, ovaries, etc. Especially is this true of certain species known in Japan, one of which is believed to cause the disease called “kakke,” which prevails during the summer months in Tokio. A certain species of fish (*Clupea venenosa*) inhabiting the West Indian waters is supposed to be always poisonous, although the source or true character of the poison is doubtful. In Russia many cases of ichthyismus have resulted from eating both the fresh and preserved sturgeon and salmon meat that are affected with an infectious disease peculiar to the fish. In Germany and others parts of middle Europe a severe form of gastritis called “Barbencholera” follows the eating of sick barbels.

The use of tainted preserved and canned fish, eels, oysters, mussels, crabs, lobsters, and the like, is more frequently the cause of symptoms of poisoning, however. Brieger’s *mytilotoxin*, the active poison formed in some mussels, and the eating of which at Wilhelmshaven caused several epidemics, is probably developed only under certain favorable conditions of saprophytic infection. Deviled crabs, lobsters, and salad have also caused severe gastro-enteritis because of contamination with germs producing ptomains. Oysters have been known to convey typhoid infection (*vide* p. 24). The *symptoms* of fish- and shellfish-poisoning are variable. Sometimes marked cerebrospinal manifestations predominate, with convulsions and paralysis. Dryness and constriction of the throat, dizziness, labored respiration, disturbed vision, jerky speech or aphonia, perhaps rapid pulse, loss of co-ordination, numbness, coldness of the extremities, dilated pupils, paresis, collapse, and death within a few hours, may ensue.

Other cases have a pronounced gastro-intestinal or choleraic group of symptoms, with nausea and vomiting, pain, tenesmus, and mucous and bloody stools. In some of them marked cutaneous irritation is shown by erythema, great heat and itching, urticaria, and swelling. Dyspnea, lividity, and sometimes delirium have also been noted. The *prognosis* is grave in many instances. The *treatment* is similar to the above—namely, emetics, purgatives, enemata, and lavage. The indications are to be provided for as they arise.

GRAIN- AND VEGETABLE-POISONING

Ergotismus.—Epidemics of ergotism have resulted from the continued use of meal made from contaminated grains grown on virgin soil. The parasite (*Claviceps purpurea*) is a fungus that infests rye and other grains; it does not, however, grow readily where the soil is well cultivated, and epidemics of ergot-poisoning are much less frequent than formerly, if we except certain places in Spain and Russia. According to Kobert, three poisonous substances are found in the ergot: ergotinic acid, sphacelinic acid, and cornutin. The first of these is not poisonous when taken into the stomach; the second is supposed to cause

sult of the action of the toxic substance, the anaphylatoxin, elaborated at the time of reintroduction of the protein. The foreign protein that may produce injury may be, for example, blood-serum, producing the well-known serum sickness following injection of diphtheria antitoxin: it may be a plant pollen, the inhalation of which causes hay-fever or asthma; but in the present discussion we are concerned only with the hypersensitiveness produced by foods. This hypersensitiveness may be produced by any of the proteins of the usual food-stuff which under ordinary circumstances in non-sensitized individuals may be taken with impunity. Certain foods are more likely to cause anaphylaxis than others, thus egg, milk, fish, especially shell-fish, pork, mushrooms, strawberries, buckwheat, and cheese have been found to cause hypersensitiveness in many instances. The hypersensitiveness may be inherited, or acquired in some unknown manner. In the acquired forms of food susceptibility it is to be presumed that the gastro-intestinal mucous membrane is abnormal, as, for example, the seat of a chronic catarrh.

The **symptoms** may vary from a mild attack of indigestion to severe prostration with a diarrhea, abdominal pain, vomiting, subnormal temperature, and a cold clammy skin. In addition to the general and gastro-intestinal symptoms, other symptoms may arise alone or in combination with the former. Thus, asthmatic symptoms are frequently directly dependent upon food intoxication, and certain vasomotor and skin lesions are common, among which may be cited urticaria, angioneurotic edema, erythema multiforme, and so on.

Auer and Robinson have shown that alterations in the heart rhythm and partial or complete heart-block may arise in acute shock. Besides the acute manifestations of anaphylaxis certain chronic conditions are apparently attributable to chronic poisoning, notably eczema and asthma. Longcope has shown that repeated injections of foreign protein in animals previously sensitized produces extensive focal degeneration of the heart muscle cells as well as those of the kidney and liver. It is thus fair to presume that repeated protein poisoning may be one of the causes of chronic degenerative disorders.

Diagnosis.—Frequently the patient learns to recognize that certain articles of the diet may cause a severe upset. In other cases the diagnosis may be made upon the symptoms, the correlation of gastro-intestinal manifestations, urticaria, and respiratory symptoms indicating the nature of the disorder. If anaphylactic poisoning is suspected the nature of the offending protein may be determined by skin reactions. These tests are performed as is the von Pirquet tuberculin test and a positive reaction is much the same—a whitish wheal surrounded by a well-marked erythema appearing within several hours. An aqueous solution of the suspected food may be rubbed into the skin abrasion, or the pure protein, which may be purchased in the open market, may be employed.

Treatment.—The acute attacks are handled by the ordinary measures to control shock, viz.: stimulation, heat, and so on. It is advisable to empty the intestinal tract by an active purge. Atropin has been shown to control anaphylactic shock in animals, as has adrenalin. They should be given hypodermically, gr. $\frac{1}{160}$ (0.00065 gm.) of the former, 10 to 15 minims (0.6–1.0 c.c.) of the latter in a 1 : 1000 solution. Calcium chlorid may be given by the mouth.

The cure of hypersensitiveness is only possible when the offending protein is known. It should be given in very small, gradually increasing doses, until immunity is secured. For example, Talbot, in treatment of children sensitive to egg albumin, gives minute doses in capsules, gradually increasing the dose every couple of days until the child can take whole eggs without any disturbance.

OBESITY

(*Polysarcia Adiposa; Lipomatosis Universalis*)

Definition.—Corpulence, or the presence of an excessive amount of bodily fat, may be said to begin to take the form of a metabolic disorder when it becomes an inconvenience or impairs the bodily functions. Many recent writers regard obesity as being symptomatic of a variety of underlying pathologic conditions (*e. g.*, pituitary disease) rather than a disease.

Pathology.—The chief alteration is the marked and, in some instances, colossal increase in the fat deposit throughout the body. Not only is the adipose tissue greatly increased in localities where it is normally found, but the various internal organs and tissues that are normally quite or nearly free from fat may in obesity show a decided fatty infiltration. The round fat face, “double chin,” broad and deep chest, large waist, thick and prominent, sometimes overhanging, abdominal *panniculus adiposus*, and bulky, cylindric, and apparently shortened extremities, are familiar appearances *postmortem* as well as *antemortem*.

There may be differences in the number and size of the fat-glubules in the histologic elements. Thus, in the plethoric form of obesity the cellular fat-globules are larger than those of the anemic or hydremic form. The heart is overlaid with fat. Hypertrophic dilatation is often present.

The *arteries* may show fatty changes and chronic endarteritis with sclerosis. The *veins* are often affected with varicosities. In plethoric obesity the blood shows an increase in specific gravity (1.062–1.070). The erythrocyte count may rise to 6,000,000 per cubic millimeter. Passive congestion and edema of the *lungs*, secondary to the cardiac weakness, are common. The *liver*, *lungs*, and *kidneys* may be enlarged, owing to fatty infiltration. Chronic interstitial nephritis may form a complication.

The *stomach* may be dilated, and often shows a catarrh of the mucosa.

Pathogenesis.—Obesity is probably dependent on a disturbance of cell activity, and this disturbance of metabolism may be transmitted through heredity (*vide infra*). The overuse of carbohydrates leads directly to fat increase. The consumption of proteins may also result in a fat-forming non-nitrogenous residue, which if not oxidized may produce fatness (see also Etiology).

Etiology.—Among the chief *predisposing* conditions are heredity, climate, habit, occupation, temperament, age, and sex. Among 543 of my cases, in which the family history was noted, heredity was distinctly traceable in 60.7 per cent. Gout was either in association or occurred among the antecedents in 43.2 per cent. of these cases and the same was true of “rheumatism” in 35.5 per cent. The condition of 10 dates from longer or shorter periods of enforced rest, *e. g.*, following accidents and infective diseases, as typhoid fever (in 4.7 per cent. of 543 cases). The disease dated from child-birth in 16.2 per cent. of the cases and from marriage (apart from child-birth) in 4.8 per cent. among 437 females. The menopause has little if any influence. Corpulence is much more frequent among the inhabitants of hot, moist climates, and of low countries of the temperate and arctic regions. Thus it is commonly observed among Orientals, Dutchmen, South Pacific Islanders, Southern Italians, and certain African races. Sedentary habits and occupations form common predisposing factors. The sluggish, luxury- and rest-loving, phlegmatic temperament also favors an abnormal fat deposition. As regards the age, polysarcia generally makes its appearance in persons of advanced middle life, between forty and fifty years, while hereditary obesity dates from infancy and early childhood; in women, it may appear at puberty and between thirty and

forty years of age. Women, and especially Jewesses, seem to be more subject to corpulence than men. Congenital anomalies and monstrosities (idiots, cretins, acephali), also anemics and hemiplegics, are often excessively fat. Extreme degrees of obesity are practically always due to endocrine dysfunction.

The *exciting* causes of obesity are especially the ingestion of too much fat-making food, the intemperate use of alcoholic beverages, especially beer, ale, and porter, with or without deficient exercise. The fat may be derived from an excess of albumin, fat, or carbohydrates. An excessive diet of starches and sugars acts indirectly as a fat-producer by lessening the oxidation of the ingested fat and of the fat formed from proteins, because the carbohydrates themselves are so readily oxidized.

Symptoms.—Obesity is not accompanied by any bodily symptoms at first. Except some inconvenience, and a sense of burdensomeness during walking or working, nothing may be complained of for years. With the progressive development of the disease, however, and particularly with the involvement of the viscera, subjective manifestations increase in number and intensity. Usually the earliest troublesome symptom is *breathlessness* on exertion, due to a weak heart and to the hampering of respiration by heavy chest walls and the upward crowded diaphragm. In *plethoric* individuals the face is red and congested, as are also the mucous membranes (conjunctivæ, labiæ). In *anemic* subjects (usually women) the skin is pale, the muscles are flabby and weak; the pulse is small and compressible, and dyspnea, palpitation, inclination to rest often and sleep much, and dizziness (symptoms of anemia and chlorosis) are manifested. On the other hand, in plethoric, corpulent subjects (usually men) the muscles are firm and strong, and the pulse and heartbeats vigorous; later, however, the latter becomes weak and irregular. Brachycardia is not infrequent. MacDowell believes that insufficiency of either ventricle, or of the auricles, is largely due to some upset in the endocrine system. The signs of fatty heart (*vide* p. 664) are obtained on physical examination. Muscular power may diminish and irregular fat masses (in the anemic variety) in subacuteaneous tissue are obtained on physical examination. Muscular power may diminish rapidly. Intercurrent acute infections (typhoid fever, pneumonia) are badly borne, and hyperpyrexia is usually associated with them. In the anemic form the blood changes are of the chlorotic type, while in the plethoric both the hemoglobin percentage and erythrocytes are increased.

The *liver* may show enlargement. The passive congestion of the *respiratory mucous membrane* is often signaled by cough and distressing dyspnea and attacks of asthma. Profuse sweating is common. There may be *polyuria* or *oliguria*, according to the activity of the skin and kidneys, at the same time. Uric acid and the urates are usually found to be increased.

Symptoms of *gastric catarrh* and *gastrectasia* may occur. Great thirst and bulimia are noted in some instances. Constipation may be followed by chronic diarrhea. Sexual desire is often abated, and azoöspemia is not rare. Corpulent women often suffer from uterine displacement and prolapse. Amenorrhea, sterility, endometritis (congestive), leukorrhea, and an aggravated climacteric are seen in obese women also. The skin is often irritated (intertrigo) by the excessive sweating, and by the friction of cutaneous surfaces in the folds of fat, as under the breast, at the abdominal and inguinal folds, and around the scrotum and labia. This may be followed by eczema. Painful excoriations, pruritus, acne rosacea, and alopecia are also not uncommon.

Complications.—Hernia, cardiac asthma, bronchitis, pulmonary congestion, edema, arteriosclerosis, albuminuria, glycosuria, anginal attacks, Cheyne-

Stokes' respiration, cerebral hemorrhage, and coma may manifest themselves as the precursors of the final stage.

Diagnosis.—This is not difficult in most cases. Care should be exercised in detecting complications and sequelæ. In myxedema the skin is thick and inelastic, and the physiognomy much altered, while the lips, tongue, nostrils, and mouth are all thickened by infiltration.

The **prognosis** will depend upon the peculiar features of each individual case, the cause and its removability, and upon the variety, degree, symptoms, and prevailing complications.

Treatment.—**Prophylaxis** is important in the earlier years of those showing an hereditary predisposition to corpulence. The fat-forming (farinaceous) substances must be diminished in the dietary. The proportions of fat and protein in the food must be regulated according to the amount of muscular activity, and the latter should be encouraged in fresh air, along with cool bathing. In those predisposed to polysarcia, all imprudences in eating and drinking should be cautioned against, and the quantities of various articles of food and the time of eating regulated. Outdoor sports and gymnastics should be also gaged accordingly.

The **dietetic** treatment of confirmed obesity is all important. Inseparable from this is the stimulation of the bodily forces that oxidize and destroy the fat. These two means are utilized in the principal methods of treating obesity, and that method must be selected which invigorates, while at the same time it involves no weakening of the patient.

The principal systems of dietary are those known by the names of Banting, Ebstein, and Oertel.

In "Bantingism," sugars, fats, and starches are greatly reduced in the diet-list; water, however, is not restricted, and vinous and spirituous liquors are permitted. In those of a rheumatic or gouty diathesis Banting's heavy protein and alcohol dietary is not to be recommended. It is best, I think, to exclude alcohol in most cases, owing to its effect in diminishing tissue oxidation and in retarding cell metabolism. This method fails to secure elimination of waste products.

In Ebstein's diet-list more than double the amount of fat and carbohydrates is permitted as compared with Banting's list, while the albuminous substances are diminished. Fat is freely allowed, as this does not increase stored fat (?), but tends to impair the appetite, while sugar and potatoes only are strictly forbidden.

Oertel allows more fat than Banting, but less fat and more (about double the quantity) proteins and carbohydrates than Ebstein. The amount of free water permitted daily is only 1 pint; about 1 pint additional in other food is allowable. This method is adapted to cases of obesity with feeble hearts and of the anemic form.

Oertel writes: "The body stores up fat if more than 118 grams of albumin and 259 grams of fat, a total of 277 grams (2894 calories), are taken in. On the other hand, 110 grams of albumin and 600 grams of starch, a total of 710 grams (2944 calories), may be given without producing a deposit of fat. With a mixed diet the limit lies near 118 grams of albumin, 100 grams of fat, and 368 grams of starch, a total of 586 grams (2923 calories)." His diet-table for obesity is appended:

	Albumin.	Fat.	Carbohydrates.	Calories.
Minimum	156	25	75	1180
Maximum	170	45	120	1608

Oertel gives a special diet-list in circulatory disturbances.

On the basis of Voit's laws, Strümpell recommends in the average cases 125 gm. (4 oz.) or more of albumin, 40 gm. ($1\frac{1}{4}$ oz.) of fat, and 150 gm. (462 oz.) of starch. Schwenniger's rule differs from Oertel's merely in the forbidding of liquids with the meals and in permitting their use only after two hours have elapsed. Yeo's diet-list is also a useful guide. In plethoric obesity (usually associated with or dependent on gout) a judicious rearrangement of the food (some increase of the albuminoid substances), coupled with sufficient muscular exercise (walking, horseback-riding, bicycling, rowing, swimming, gymnastics), accomplish successful reduction, as a rule. Moritz has found an exclusive milk diet extremely effectual.

Increasing weakness of the heart with an impeded circulation naturally diminishes the excretion of water by the cutaneous and renal routes. In such cases the circulatory system must receive careful attention and the consumption of fluid must be limited. If evidences of anemia be present, the amount of liquid may be much restricted, the total per diem not exceeding 1 liter (quart) and the fat-forming dishes rigidly excluded. "The hydremic form must be opposed by the ingestion of an abundance of albuminoid material, of fat-producing substance, and the hydrocarbons" (Oertel). Cases of obesity in which diabetes or hyperglycemia is associated should receive an antidiabetic diet. Sabbe and Furet recommend a regimen from which salt is entirely eliminated, in connection with the ingestion of fluids in abundance, which carries off excrementitious products. There are cases in which a large part of the excess of weight is due to retention of water; in such, a salt-poor diet may be employed with marked success. Under any system of dietetic treatment the patient should be weighed accurately and frequently, and the food limit be diminished or modified according to the results. The food may be weighed and measured at first, but the patient soon learns to estimate by bulk the requisite quantity of each substance.

The following dietary illustrates what may be ordered in many cases:

Breakfast.—Fruit, as an orange or 2 peaches or half a grapefruit (without sugar), or a sour apple; fine wheat bread, $1\frac{1}{4}$ ounces (0.4 gm.); a soft-boiled egg; milk, 1 ounce (30 c.c.); saccharin, $\frac{1}{2}$ gr. (0.03 gm.); coffee, $4\frac{1}{4}$ ounces (127 c.c.).

Luncheon.—Caviar, 2 drams (8 gm.); lamb chops, sweet breads, boiled ham (cold), or fowl or game in season, 3 to 4 ounces (90–120 gm.); salad, 1 ounce (30 gm.) (with a small amount of French dressing); cheese, 1 dram (4 gm.); bread, rye or bran, $\frac{1}{2}$ ounce (15 gm.); fruit (except strawberries and bananas), or instead of the latter, 4 ounces water (120 c.c.).

Dinner.—Soup (clear), 3 ounces (90 c.c.); fish, 2 ounces (60 gm.); roast or broiled beef, lamb, veal, or game or poultry, 4 to 5 ounces (120 to 150 gm.); one or two of the following green vegetables: spinach, string beans, green peas, celery (stewed), asparagus, raw sliced tomatoes, Brussels sprouts, $1\frac{1}{2}$ ounces (45 gm.). For dessert the patient may take plain rice pudding, junket, cup custards (all slightly sweetened), or fruit (except strawberries and bananas), either raw or cooked, 4 to 5 ounces (120 to 150 gm.). The patients may take 4 to 5 ounces (120 to 150 c.c.) of water when fruit is not used.

Additionally, a glass of water on rising and three hours after each meal is to be taken, and during the warm season from 1 to 3 glasses over this amount.

Galisch recommends the simple measure of reducing the amount of food taken after midday, so as to lessen nourishment at night, out of which to build fat. Folin and Denis¹ suggest, as a perfectly safe, rapid, and effective method of reducing the body weight of very obese persons, repeated fasts of increasing duration, the ammonia or beta-oxybutyric acid determination being used as a guide to the length of each fast.

¹ *Jour. Biol. Chem.*, 1915, xxi, 183.

The ~~mechanical treatment~~ to increase oxidation), by exercise, is to be used in conjunction with the dietetic. The form of the exercise, and also the time and frequency, must be adjusted for each case (*vide supra*). Unless the muscular exercise be taken with conviction, treatment will probably fail. When cardiac dilatation and myocardial degeneration (fatty) are the cause of symptoms of precordial distress, dyspnea, and palpitation, resort may be had to Ortel's system of graduated walking on the level or climbing along "health paths" *vide* Fatty Overgrowth, p. 654). Or the well-known Naubem or Schott treatment may be used. Great care must be exercised in prescribing the mechanical treatment in obese persons who have atheromatous vessels.

The medicinal treatment is neither satisfactory nor successful. Causative or associated conditions—*v. g.* gout—may present special therapeutic indications. The juice of the physalis berry may reduce the weight, but is harmful.

The use of thyroid extract is quite extensive. Liechtenstern, Wendelstark, Ewald, and others have reported success in a number of cases, especially in those exhibiting the anemic, flabby, "myxedematoid" form of obesity. The loss of weight was from 2 to 3 pounds (1–1.5 kgms.) in one week, and as high as 20 pounds in two to four weeks. In 2 of my own cases belonging to this category the use of thyroid extract (desiccated) in small doses (gr. j—0.065, t. i. d.) caused a progressive loss of weight at the rate of 4 to 6 pounds per week respectively, without injury to the general health. In cases in which dietetic measures with exercise fail, thyroid insufficiency should be suspected, and thyroid treatment instituted. Jump states that in the constitutional or thyrogenous type, in which a small or inactive thyroid and poor catabolism are associated, thyroid extract may be given with care. Thyroidin, the active principle of the thyroid gland, as shown by Baumann and Ross, and iodothyryl give results that are perhaps as good as those of thyroid feeding. The dried extract should be employed and the commencing dose small (gr. ss to j—0.03–0.06), to be gradually increased, and symptoms of thyroidism are the signal for a reduction in the dosage (*vide* Myxedema, p. 500). Hematicinics are indicated in the anemic variety of obesity. Arsenic also promotes metabolism of albumin. Finally, the treatment must be adapted to the special case, and also varied from time to time to meet indications and complications as they arise.

HYPOPHYSEAL OBESITY

In 1901 Fröhlich first described this condition; it is characterized by a tumor (adenoma, carcinoma, etc.) of the hypophysis accompanied by monstrous general obesity and atrophy, or delayed development, of the genital organs. These subjects have a high tolerance to carbohydrates. The syndrome being due to hypopituitarism, they are naturally benefited by the use of extracts of hypophysis. Other glands with an internal secretion may, when their function is disturbed, produce pathologic obesity (pineal gland, suprarenals).

ADIPOSIS TUBEROSA SIMPLEX

The writer has described a condition which resembles adiposis dolorosa (Dercum's disease) clinically, but differs from the latter in that it is dependent upon general obesity, and is, therefore, amenable to treatment.

"Circumscribed fat masses appear in the subcutaneous tissues; they form distinct, moderately dense, slightly movable, somewhat flattened tumors, ranging in size from a bean to that of a hen's egg. Their number varies all the way from one-half dozen to two dozen or more. These moderately firm

fat-nodules are not distributed over the entire body, but in some cases are confined to the extremities, particularly the lower, and in others to the abdomen. The tumor masses show no tendency to fuse together, and are not elevated above the surrounding surface; they are sensitive to the touch, and may be the seat of pain, which varies in intensity within rather wide extremes, being moderately severe and distressing in rare cases and trivial or even absent in the majority of instances. The lymphatic glands are not involved, and the skin remains soft, flexible, and non-adherent. The mental processes are normally active, and also the muscles; asthenia is not present, and there is no more indisposition to physical exertion than is observed in cases of obesity, as a rule. The knee-jerks are present, and the cutaneous sensibility is unaltered, in some cases at least the *mammæ* and abdominal panniculus adiposus may be overhanging or pendulous, but not in all cases. It is an uncommon condition, since it was noted in only 4 out of a total of 324 cases" (Anders).

HEAT-STROKE

(*Sunstroke; Insolation; Thermic Fever; Heat-exhaustion; Heat-prostration*)

Definition.—A diseased condition the effect of exposure to excessive heat.

Pathology.—*Rigor mortis* is marked and comes on early. The high temperature of the cadaver accelerates the putrefactive changes, which also appear early. There is considerable venous engorgement of the brain and of the cerebral and spinal membranes; also of the lungs, spleen, and conjunctiva. The blood is fluid and dark, and the corpuscles are crenated and do not tend to form rouleaux. Parenchymatous changes in the liver and kidneys may be found. Rigid contraction of the left ventricle is a notable feature, while the right ventricle is usually dilated with blood. Van Gieson's recent report of the cellular pathology of the cerebrospinal system in 3 cases of sunstroke in New York shows an acute parenchymatous degeneration of the neurons of the whole neural axis similar to that of "a species of auto-intoxication."

Etiology.—Anything that lessens bodily resistance to external high heat predisposes to heat-stroke. Thus, privation, unsanitary surroundings, fatigue of body or mind, emotional excitement, worry, and excessive fretfulness, over-eating, indulgence in alcoholics (especially), clothing suitable for cold weather worn on hot days, and previous attacks of sunstroke, are all conducive to heat-stroke on exposure to high temperature. Males are affected more often than females, and the condition is rare in childhood. The colored race is more resistant than the white to the effect of the direct solar rays.

Sunstroke occurs in persons (on land) working hard under the direct rays of the sun, in an atmosphere that is very hot and humid, still, and sultry. Soldiers on the march and heavily accoutered, masons, bricklayers, hod-carriers, roofers, drivers, farmers, and other out-door laborers are particularly subject to insolation.

Heat-stroke and **thermic fever** are terms more appropriately applied to those similarly affected in midsummer while working in places not exposed to the sun, but yet close, confined and excessively hot, such as glass-works, foundries, ocean steamers, stoke-holes, boiler-rooms, steam laundries, sugar-refineries, kitchens, and the like.

Heat-exhaustion (*prostratio thermica*) is caused under similar conditions as the preceding, but manifests dissimilar effects.

The majority of the cases of sunstroke occur between 2 and 5 P. M., although

¹ *Amer. Jour. Med. Sci.*, March, '06

heat-stroke and heat-exhaustion may occur at night as late as 10 or 11 P. M., as among bakers, night engineers, and hotel cooks.

The direct cause of the symptoms of the sunstroke, heat-stroke, or heat-prostration is the action of the excessive heat upon the heat-centers, or upon the vasomotor center or nerves (H. C. Wood), the former of which, if paralyzed, produces *thermic* or *heat-fever*, while the latter, if paralyzed, produced *heat-exhaustion*. Lambert and Van Gieson, after a clinical and pathologic study of 805 cases, hold to the view that the immediate basis of sunstroke is auto-toxic, with heat only as a contributing cause. Sambrook contends for the infective nature of heat-stroke and thus explains its endemic and epidemic proclivities.

Symptoms.—Two forms of heat- or sunstroke are usually met with: (1) The *asphyxial* or *apoplectic form*; (2) the *hyperpyrexial form*. Flint believes that the majority of the cases of sunstroke are combinations of apoplexy and exhaustion. Vallin puts all cases of insolation into two classes: the first sthenic or asphyxial, corresponding to our hyperpyrexial or congestive variety; the second, asthenic or syncopal, corresponding to our heat-exhaustion. Mixed forms may occur quite frequently, the most prominent symptoms being referable to the organs suffering the most, as the cerebrospinal system, heart, lungs.

Heat-apoplexy (*asphyxial sunstroke*) is probably the least frequent form. There may be sudden premonitions, or dizziness, chromatopsia, throbbing headache, cessation of sweating, or dyspnea. Sometimes the patient, while at work in the sun, suddenly falls unconscious, a few convulsions may occur, and in this state he may die with symptoms of cardiac failure. More often, insensibility is not so profound as complete coma, there is much restlessness, epigastric "cramp" may be complained of, also a sense of thoracic oppression, and occasionally there are nausea and vomiting. The headache may be intense, the face is flushed, the pulse is rapid and full, the temporal and carotid arteries are bounding, the breathing may be labored and stertorous, the pupils are contracted. The skin is hot and dry, and may show petechiæ. The tongue is coated. A wild delirium has been observed in some cases. The temperature may be subnormal, and is not higher than 102° F. (38.8° C.) in many instances. In others, a mild degree of thermic fever may be associated with the apoplectic condition, the thermometer registering 104° to 106° F. (40°–41.1° C.). In fatal cases the coma becomes deeper and deeper, the pulse more rapid and feeble, and Cheyne-Stokes respiration may precede the termination. A "mousey" odor about the body has been noted. In favorable cases the temperature falls to normal by lysis in three or four days, consciousness being rapidly regained at the same time.

The *hyperpyrexial* variety comprises the numerous cases of marked sunstroke that resemble the preceding type, with the addition of an intensely high temperature (*thermic fever*). The patient may suddenly become comatose and die in an asphyxiated condition, with a temperature as high as 110° to 115° F. (43.3°–46.1° C.) or even higher.

Sometimes prodromes, as an anorexia, progressively increasing physical weakness, cramp-like abdominal pains, irritability and restlessness, vertigo, colored and blurred vision, lack of sweating, a "bursting" headache, and an irritable bladder may exist for several days. A subconscious (automatic) state, in which the patient may be unaware of his surroundings, although walking or even working, may be noted for hours before he is stricken down. The onset is marked by hyperpyrexia; the skin is hot, burning, dry, sometimes flushed and red, and sometimes cyanotic and clammy; the eyes are suffused or "staring and filling," with pin-point pupils. There is a full, rapid, and non-

compressible pulse, and coma may be present. Clonic spasms may alternate with either muscular rigidity or flaccidity. Delirium, moaning, jactitation, and explosive expiratory sounds may occur. There is frequently incontinence of both feces and urine. The temperature is very high in most of the cases, varying from 105° to 112° F. (40.5°–44.4° C.).¹ The pulse-rate varies with the temperature, from 90 to 160 beats per minute. The respirations are also increased to 24 to 50 per minute. Many of the alarming symptoms, including the high fever, unconsciousness, cyanosis, dyspnea, and convulsions, may greatly subside during and after the use of the cold bath. Secondary exacerbations occur for a few days before convalescence is established in the favorable cases (*vide* chart, Fig. 80). Some patients never rally and die in a state of asphyxia.

AUGUST

Fig. 80.—Chart of a case of sunstroke. C. B., aged twenty-nine years. Recovery.

Retention of urine (suppression) is observed at times, and particularly in those accustomed to the use of alcohol. Leukocytosis is noted.

Fatal complications of sunstroke are pneumonia, meningitis, uremia, and cardiorespiratory paralysis.

Heat-prostration or *heat-exhaustion* may come on gradually or suddenly, with prodromal symptoms (dizziness, faintness, headache, nausea, thirst, drowsiness, yawning, epigastric or lumbar pains, numbness, and tingling of the hands and feet). These are followed by coldness, clamminess, and pallor of the surface, marked muscular weakness and prostration, a small, febrile, rapid pulse, sighing breathing, syncope, and collapse in the graver cases.

¹ Lambert reports a case in the New York Hospital of 117.8° F. (47.6° C.).

The temperature at first is subnormal (95° to 97° F.— 35° – 36.1° C.), though mild thermic fever of from 100° to 102.5° F. (37.7° – 39.1° C.) may be present. Consciousness is rarely completely absent. Recovery usually takes place within one or two days, and in milder cases, under prompt and appropriate treatment, within a few hours. In a few cases of extreme prostration in weakly persons death may ensue from cardiac failure.

Sun-traumatism (Manson) describes a condition characterized by sudden death from paralysis of the heart or respiration after exposure to the sun. *Siriasis* occurs only in high temperatures, and is characterized by pulmonary congestion, coma, and hyperpyrexia. *Heat collapse* from exposure to the sun is often seen on hot summer days and is too transient to be called sunstroke. The temperature is normal or slightly elevated, and the respiration shallow and rapid.

The sequelæ of heat-stroke are quite interesting. Osler relates the case of a patient who "was subsequently so sensitive to temperatures in the neighborhood of 75° F. (23.8° C.) that he lived comfortably only in the cellar, and finally sought refuge in Alaska."

Chromatopsia, severe headaches, irritability and ugliness of temper, or delirium may occur in some patients as soon as warm weather sets in, and may be due occasionally to chronic meningitis (Wood).

Heat-cramps may develop among those exposed to high artificial heat while doing muscular work—*e. g.*, stokers on steamships, workers in iron foundries. It is essentially a continuous fibrillary contraction of the muscles, especially those of the calves. The condition is attributable to an acute degenerative process in the muscles (Edsall). Painful, tonic spasms of the muscles, more particularly of the forearms and legs, occur in paroxysms, lasting from one-half to one minute. The duration of an attack of heat-cramps is usually less than twenty-four hours, and it is followed by muscular soreness and slight exhaustion.

Diagnosis.—Bearing in mind the characteristic differences that are outlined above between sunstroke (asphyxial and hyperpyrexial forms) and heat-exhaustion, the diagnosis is not difficult. The history and circumstances attending the seizure are also important factors. From other affections, as *acute alcoholism*, *meningitis*, *uremia*, and *cerebral apoplexy*, the differentiation is readily made by noting the previous history, mode of attack, presence or absence of thermic fever, state of consciousness, urine, skin, pupils, pulse, respiration, and nervomuscular apparatus. *Malaria* can be excluded by a blood examination.

Prognosis.—This is usually favorable in cases of heat-prostration and heat-cramps. It is less so in sunstroke, but in all cases it depends on the severity of the stroke, the previous health and habits of the patient, the complications, and the promptness and facility of the treatment. In general, cases in which unconsciousness lasts from twenty-four to forty-eight hours terminate fatally. The mortality rate during a prolonged period of hot and humid weather may be very high, ranging from 15 to 50 per cent. In New York City, during the week ending August 15, 1896, out of a total number of 1810 deaths, 648 were reported as due to sunstroke (Lambert).

Treatment.—Prophylaxis.—This is highly imperative in hot, sultry weather, in which persons must work in the sun or in poorly ventilated and highly heated closed places. Workmen should be taught and warned privately and publicly, as through the medium of the press and Health Board circulars, to take extra precautions during hot weather, to work and sleep in as well-ventilated rooms as possible, and to secure artificial ventilation, if necessary. They should live regular and temperate lives, avoiding alcohol and heavy

eating; oatmeal water should be drunk, light-weight and light-colored clothing should be worn, and the direct rays of the sun should be avoided as much as possible. The condition of the skin should be watched and care taken that sweating continues freely. Shelter or rest should be sought at once if sweating stops. Cool wet cloths or green leaves should be worn inside a light straw hat, and sometimes it may be necessary for employers to shorten the hours of labor during the hottest part of the day.

Treatment of the Attack.—Cases of ordinary *heat-prostration* seldom require much treatment beyond the removal of the patient to the shade of a comparatively cool place, loosening all constricting clothing, spraying with cool water, the use of ammonia or amyl nitrite inhalations, and of the aromatic spirits of ammonia or nitroglycerin by the mouth. If the temperature is subnormal and collapse threatens, a hot bath is advisable. Strychnin and digitalis may be used for a day or two to combat the nervomuscular weakness.

Heat-stroke, especially the hyperpyrexial cases, must be promptly treated by the application of the ice-bath (ice floating in a tub of water), temperature about 40° F. (4.4° C.), or by rubbing, by the cold pack, or by the needle-spray with iced water for the purpose of overcoming the vasomotor depreciation.

In the *asphyxial* cases venesection is frequently indicated. The subcutaneous or intravenous injection of physiologic salt solution (F. A. Packard) may be a valuable procedure in many cases. Wooley advises a solution prepared as follows:

Sodium chlorid,	30 gm.;
Sodium carbonate (crystallized),	20 gm.;
Water,	1000 c.c.

To be given slowly per rectum. For intravenous use the following is recommended:

Sodium chlorid,	14 gm.;
Sodium carbonate (crystallized),	10 gm.;
Water,	1000 c.c.

To aid in the reduction of the cerebral pressure lumbar puncture should be done. External stimulation should be applied to the precordium by mustard and to the feet by hot bottles, and hypodermic injections of nitroglycerin, strychnin, atropin, brandy, camphor, or ether are useful. Ice should be rubbed over the head constantly. Care should, however, be taken to see that the temperature is not reduced too far. A temperature of about 102° F. (38.8° C.) should be the signal for cessation of the ice-bath, and for the removal of the patient to a cot, where he is to be rubbed dry and allowed to rest until an exacerbation of fever indicates the reapplication of the cooling measures. Ice-water enemata, with or without brandy, are often useful adjuvants. The needle-spray of cold water is an excellent nervous stimulant as well as antipyretic. It is given while the patient lies on a Kibbee or netting cot, or on a cot covered with a rubber sheet so arranged as to drain into a pail or trough. Internal antipyretics are seldom well absorbed, and their depressant action is so well known as to discourage their use in place of hydrotherapy. Hutchinson, Coplin, and Bevan recommend highly the use of morphin to control the convulsions of heat-stroke. Chloroform has also been advised. Artificial respiration in the asphyxial cases, kept up until other measures and stimulants have time to act, may be the means of saving life.

After the reduction of the hyperpyrexia the patient should be lightly covered on a cot placed in a cool place. An ice-cap should be applied to his head, and

small pieces of cracked ice may be given to allay gastric irritability, with calomel to open the bowels if necessary. Albumin-water, skimmed milk, buttermilk, unfermented grape-juice, junket, and the like may be given for several days preparatory to the ingestion of heavier food. If, as sometimes happens, free diaphoresis does not come on after the reduction of most of the fever and the stimulating treatment, a hot bath may be given, and perhaps aided by the hypodermic injection of pilocarpin in urgent cases. *Sequelæ* must be treated on general principles.

In *heat-collapse* "treatment consists in removing the patient to a cool or shady place, loosening the clothing, and spraying the face and body with cold water. He should be given a cup of strong tea or coffee. A hypodermic injection of strychnin or camphor may be needed." For the violent muscular spasms (*heat-cramps*—*vide* p. 1240) chloroform by inhalation affords temporary relief, and warm baths are recommended for their relaxing effect. H. M. Welsh¹ has employed apomorphin, in doses varying from gr. $\frac{1}{12}$ to $\frac{1}{36}$, as a relaxant in the severe cases.

The increased susceptibility to repeated attacks of insolation (after the first attack) makes it necessary to avoid exposure to heat ever after, and, if possible, to seek a cooler climate during the hot months.

¹ *Jour. Amer. Med. Assoc.*, July 22, 1916, p. 285.

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